Metal Treating

JUNE
JULY
1960
Vol. 11
#3

THE *ONLY* MAGAZINE DEVOTED EXCLUSIVELY TO THE HEAT TREATING INDUSTRY

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Metal Treating

THE ONLY MAGAZINE DEVOTED EXCLUSIVELY TO THE HEAT TREATING INDUSTRY

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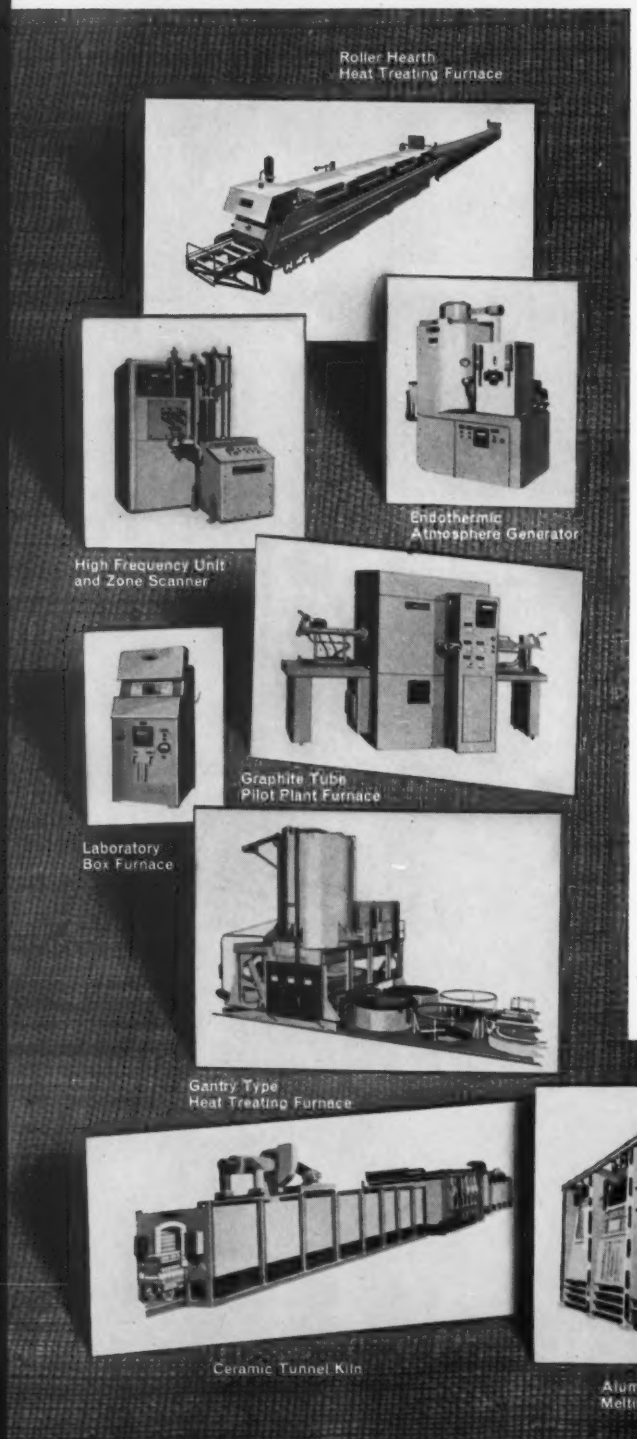
About Our Cover

Annealing of deep-drawn ferrous and non-ferrous metals has been greatly speeded up through the use of batch-type furnaces such as the one depicted. For full story, see page 4.

THE BIGGEST INDUSTRIAL HEATING JOB CAN BE ENTRUSTED TO LINDBERG'S *PLUS* DIMENSION IN SERVICE

THERE'S LINDBERG EQUIPMENT FOR EVERY INDUSTRIAL HEATING NEED



The plus dimension in service Lindberg offers today can provide a complete answer to any problem requiring the application of heat to industry. Give us your specific requirements for a part or a product and we will develop the right processes, design, engineer and install equipment and facilities.

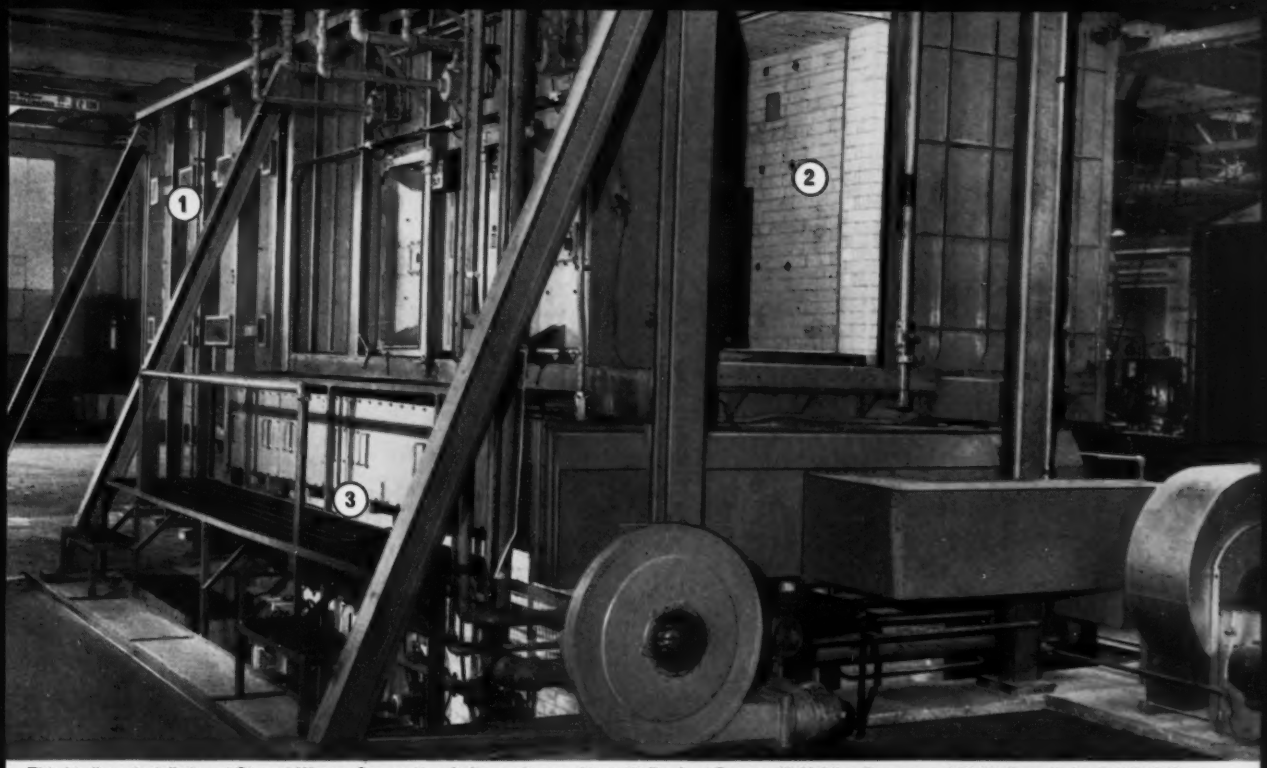
This service covers broad requirements—from plant layout and construction to automated production lines, or just specially engineered industrial heating equipment efficiently integrated into your production processes. For example, Lindberg Industrial Division has recently completed or is in the process of installing such varied projects as:

- Complete plant layout and equipment for brazing honeycomb
- Complete installation for heat treating raw aluminum products including furnaces, foundations, roof and lighting
- A fully automated production line for heat treating plow shares
- Two large ceramic kilns embodying a new concept of making high-refractory bricks
- Complete, automated production line for enameling and drying hot water heaters

You obtain many advantages from Lindberg. You get the combined skills of what we believe to be the country's finest group of engineers and technicians in the industrial heating field. Our experience covers the whole range of "heat for industry" methods so you can rely on us to recommend the most suitable equipment and processes. You will get your installation from one responsible source, guaranteed to achieve the results you need and ready to go to work at the turn of a switch.

Lindberg Industrial Division, Lindberg Engineering Company, 2321 West Hubbard Street, Chicago 12, Illinois. Los Angeles Plant: 11937 South Regentview Avenue, Downey, California. In Canada: Birlefco-Lindberg, Ltd., Toronto.

These are representative units from complete Lindberg lines in all types of industrial heating equipment.



This Lindberg installation at Stewart-Warner Corporation, Indianapolis, combines (1) Pre-heat Furnace (2) Holding Furnace and (3) Lindberg-Upton Salt Bath Furnace.

LINDBERG SUPPLIES COMPLETE INSTALLATION FOR DIP BRAZING ALUMINUM HEAT EXCHANGER CORES

Brazing large aluminum plate-and-fin heat exchanger cores requires close tolerances and precise controls. Stewart-Warner Corporation, Indianapolis, chose Lindberg Industrial Division to design and install the right equipment to perform this exacting process efficiently and economically. The main unit, shown above, combines Lindberg Preheat and Holding Furnaces and Lindberg-Upton Salt Bath Furnace. Cores are brought to the desired temperature, moved to holding furnace section, then lowered into the salt bath. Automatic controls maintain required salt bath temperature to extremely close limits. Brazed cores are raised to holding furnace for drainage, moved through a cooling chamber, steam cleaning booth and five dip rinse tanks for thorough cleaning. This installation is another example of the complete design, engineering and installation service Lindberg Industrial Division offers industry. Whenever you have a product or process requiring the application of heat, consult your local Lindberg Field Engineer, (see your phone book) or write us direct. Lindberg Engineering Company, 2466 West Hubbard St., Chicago 12, Illinois. Los Angeles plant: 11937 South Regentview Ave., Downey, California. In Canada: Birlefco-Lindberg, Ltd., Toronto.

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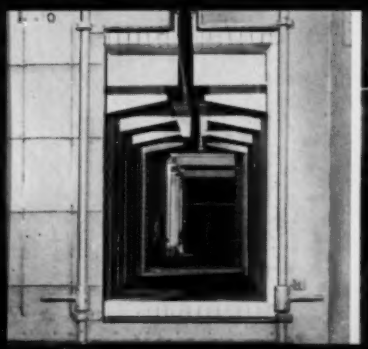
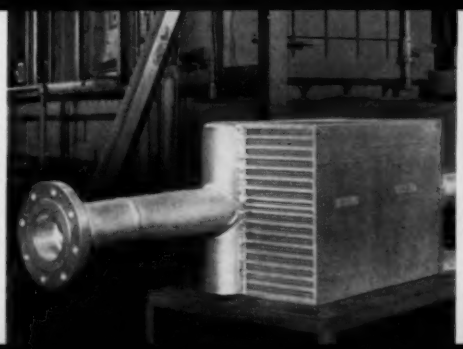
Design of unit permits convenient movement of cores through pre-heat (foreground) to holding section (at far end).



The aluminum heat exchanger cores being brazed in the unit have heat transfer surfaces of 8000 sq. ft. or more.



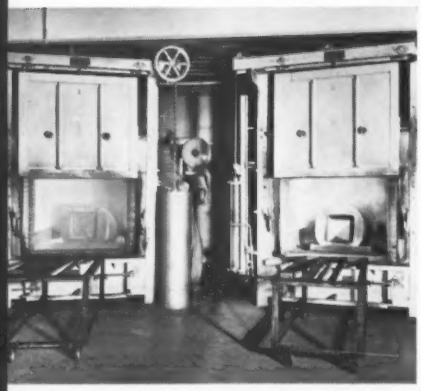
Lindberg-Upton Salt Bath Furnace in unit features exclusive Graphite "Continuing" Electrodes, and has a capacity of more than 12 tons molten salt.

OUR COVER

ANNEALING OF DEEP-DRAWN FERROUS AND NON-FERROUS PARTS

Batch-Type Furnaces Speed Processing of Great Variety of Metals and Shapes at Peterson Products

Warren A. Peterson, Jr., President
Peterson Products Corporation



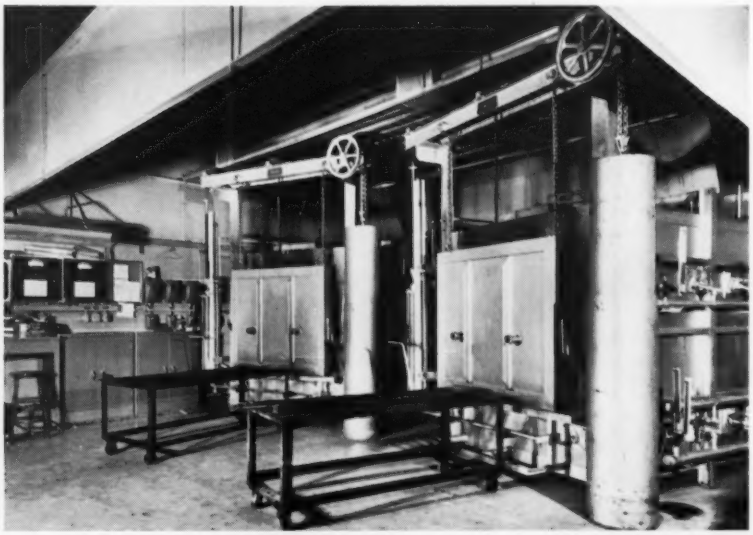
IN PLANNING the production of metal parts it is often profitable to explore the advisability of metal stamping. Parts of many types frequently may be more suitably stamped for reasons of economy, greater strength, precision or better appearance.

Peterson Products Corp., Schiller Park, Illinois is one firm which specializes in manufacturing stamped parts. In addition to the carbon steels, Peterson has had a great deal of experience in stamping and deep drawing aluminum, stainless steel, coated or clad steels, as well as numerous other metals and alloys.

Deep drawing is the forming of cup shaped parts from sheet metal by controlled plastic flow. Deep drawing tools redistribute the metal while limiting its change in thickness, in severe draws, to slight thinning at the closed end and thickening at the open end.

The color photograph on this month's cover shows a view of one of the two Surface Combustion large oven annealing furnaces in operation at Peterson Products. The furnaces range in temperature from 600 F. to 2300 F. and are large enough to process the largest die capacity which is 36 in. wide. An oxidizing atmosphere is used for aluminum and a reducing atmosphere is used with steel or copper. A neutral atmosphere is utilized for special alloys and stainless steel. Temperature uniformity is maintained at plus or minus 5 F. below 1200 F., and 10 F. above 1200 F.

Peterson Products is the country's largest job shop producer of deep cold drawn parts. Besides having unusually large press facilities, Peterson avails the services of its design engineers for parts which require new tooling or design. • • •



ISOTHERMAL HEAT TREATMENT

LESTER F. SPENCER

Technical Director Nuclear and Centrifugal Pump Department
Allis Chalmers Manufacturing Company
West Allis, Wisconsin

TRANSFORMATION BEHAVIOR IN STEELS

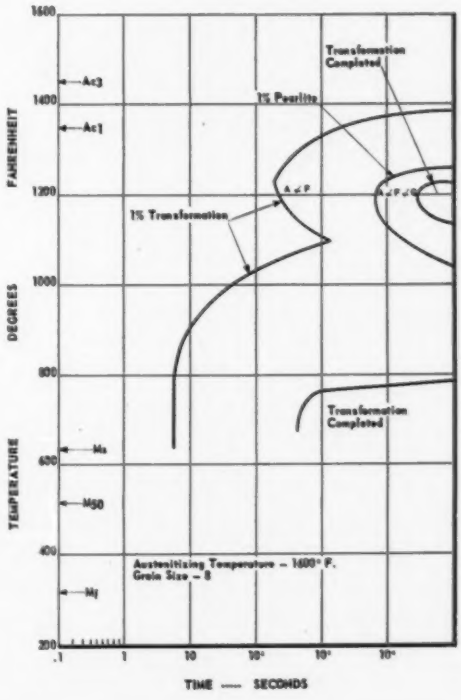
Since formal introduction of the "S" curve by Davenport and Bain in 1930, study of the constant temperature transformation of steel has increased tremendously. Due to the commercial importance of isothermal heat treatment, it may be well to describe briefly the laboratory procedure in obtaining a working diagram.

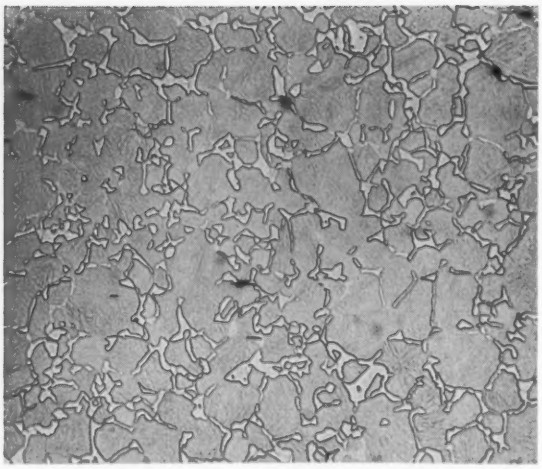
Small specimens, usually ½ in. square by ¼ in. thick are austenitized and subsequently quenched in either molten lead or salt which is maintained at a predetermined temperature (isotherm) for increasing periods of time. The amount of transformation is fixed by subsequent water quenching, whereas the progress of transformation is measured metallographically. The results are then plotted as a function of time; figure 1 illustrates a completed "S" curve for an AISI composition. As an example, following austenite decomposition within the ferrite range, figure 2a illustrates the formation of 15% ferrite after 48 hours at the 1,300° F. isotherm. An increase in time to 6 days at this same isotherm indicates that transformation has proceeded to about 30%. Figure 2b illustrates the progress of transformation within the upper bainite range, the isotherm selected being at 900° F. At 15 seconds there is 6% transformed product; at the 60 second interval, it is at 27% and after 6 days at temperature, the percent of transformation is at 45%. Finally, in figure 2c, which illustrates the progress of transformation within the lower bainite range, the progress of transformation is rapid. At 15 seconds at the selected isotherm of 700° F., there is 7% transformed product; at the 30 second interval, there is 26% and at the 2 minute interval, there is 90% transformation.

In examining the specific diagram illustrated in figure 1, one will notice that it is of the "double-nose" type in which the upper nose represents the transformation of austenite to ferrite and pearlite, whereas the lower nose represents the transformation of austenite to bainite. Since a variety of alloying combinations are possible in formulating compositions, it is reasonable to expect that the isothermal diagram (IT) will also vary and, as a result, an attempt has been made to classify the diagrams into families.

There are, however, some common features to all diagrams. Thus, in some instances, both the Ac_1 and the Ac_3 points are given; however, a great number of

FIG. 1. Isothermal Diagram for AISI 8727.





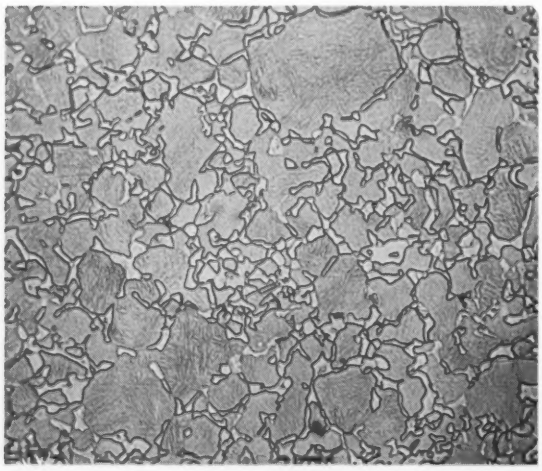


FIG. 2a. (TOP) Isotherm, 1,300° F.; time at isotherm, 48 hours; transformed product, Ferrite; percent of transformation, 15. (BOTTOM) Isotherm, 1,300° F.; time at isotherm, 6 days; transformed product, Ferrite; percent of transformation, 30.

diagrams give the Ae_1 and Ae_3 points which are based on actual determinations under equilibrium conditions. The temperature range of martensite formation is also summarized in isothermal transformation diagrams by arrows pointing to the temperature at which, on rapid cooling, austenite begins to transform to martensite (Ms), is half transformed (M_{50}), and is completely transformed (Mf). The usual method of determining these points is by a rather involved metallographic technique; however, the Ms point has been approximated by mathematical means.

While the isothermal diagram shows the time-temperature relationship for austenitic decomposition at constant temperature, it should be remembered that the conventional heat treat cycle involves transformation based on continuous cooling. Thus, the isothermal, or TTT curves may be used as a guide in planning conventional heat treating and to rationalize why an analysis responds as it does to a particular heat treatment. However, it cannot be used to predict accurately the course of transformation as it occurs during continuous cooling. This has resulted in the development of procedures, usually utilizing dilatometric equipment, in determining the transformation as it occurs during continuous cooling. The results of this is also plotted on semi-logarithmic paper as a function of time in the form of a continuous cooling or C.T. diagram. It is generally accepted that transformation that occurs during continuous cooling starts at times and temperatures considerably below and to the right of those indicated by the isothermal curves. When it is realized that the isothermal diagrams are for conditions for constant temperature, it can be used with a fair amount of reliability for those isothermal treatments under discussion, *i.e.*, cyclic annealing, austempering and marquenching.

Applications of the IT Diagram to Heat Treatment

Conventional heat treatment. The most common method of hardening steel consists of heating the material to a temperature above the Ac_3 to produce a fully austenitic structure, holding at this temperature to assure homogenization and complete solution of carbides. This is followed by quenching in a suitable media whose cooling rate is sufficiently rapid to prevent austenitic decomposition until it reaches the Ms temperature of the steel. A schematic illustration of this type of treatment in relation to the I.T. diagram is given in figure 3. The cooling curves as drawn lie to the left of the nose indicating full hardening to a martensitic structure upon quenching. One of the curves indicating cooling of the surface of a quenched piece of steel, whereas the other curve represents the cooling of the center of the same piece. The tempering operation, which usually follows the quench, is also illustrated. It does not have any bearing on the IT diagram with the exception of the event that the austenite-

to-martensite is incomplete. In this case, retained austenite transforms during tempering to the transformation product indicated by the I. T. diagram.

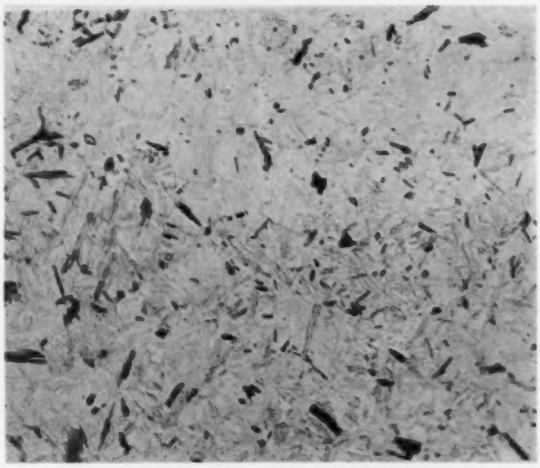
Marquenching. One of the more practical tricks that have been used for decades by production heat treaters was the use of the interrupted quench. They had discovered that a procedure involving the quenching of a carbon steel in water, then transferring the hot section for the completion of the quench in oil realized not only the full desired hardness in the quenched section, but also minimized the danger of cracking and warpage. This method, which was erratic as to the end results due to the judgment of the individual heat treater and the lack of knowledge, was usually used on those jobs which were considered "tough" to handle.

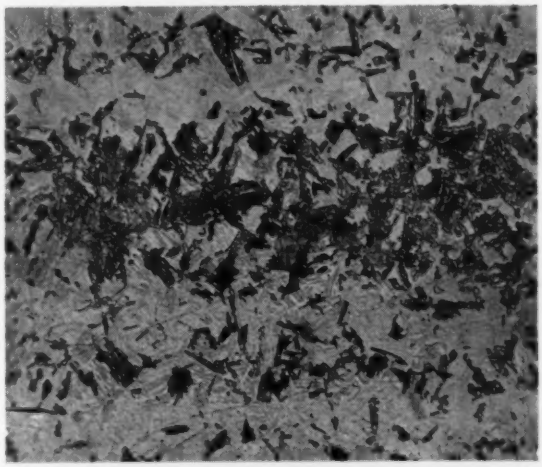
This method has been placed on a more scientific basis; the principle governing this process being determined by Lewis in England[1] in 1929, and popularized in 1942 by Shepherd as "martempering". This method utilizes a principle of hot quenching in the vicinity of the Ms point, realizing the advantages of minimum residual stress within the part which will minimize warpage and considerably reduce the tendency of cracking. Successful use of this process is based upon knowledge of the isothermal diagram and the extent of control that is exercised in all phases of the heat treat cycle.

Application of martempering, or, marquenching, is illustrated in figure 4. The material is heated in the usual manner to the austenitizing temperature and, after the completion of the required soaking period to assure full austenitization, it is quenched directly into a properly agitated salt bath or mar-temp oil, the temperature of this quenching medium being in the vicinity of the Ms temperature. If full hardening is to occur, austenite must cool with sufficient rapidity to avoid transformation at the "nose" of the IT diagram. The work is allowed to remain in the quench bath, which is accurately controlled, for a sufficient length of time to assure equalization of temperature from center section to the surface. It is then allowed to air cool. The normal tempering operation follows with the end product being tempered martensite.

In a comparison between identical analyses and section size, as illustrated in table 1, the structure of a section that has been heat treated in the conventional heating and oil quenching will have more martensite than a section that has been marquenched. In addition, the section that has been marquenched will have from one to two points lower Rockwell C hardness. The work of Carroll and Grange, which has been cited by Aborn[1] illustrates this trend. The data tabulated indicating the metallographic and hardness differential between an oil quenched, brine quenched, and marquenched sections of SAE 4150 and 52100.

It has been ascertained that the success of mar-





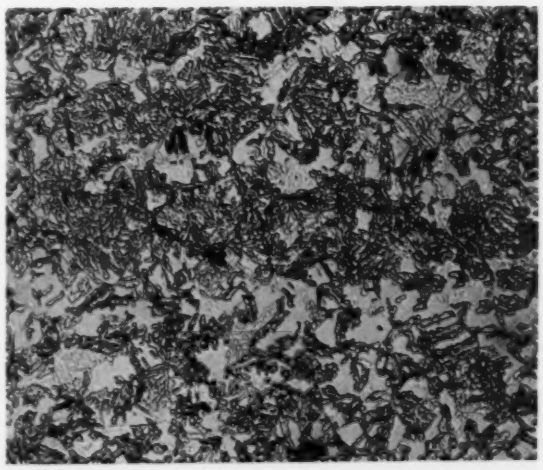
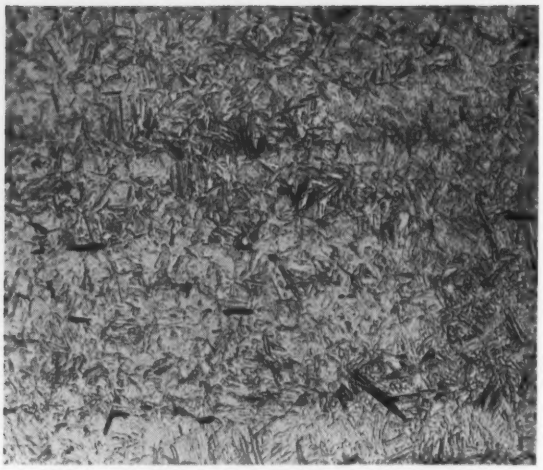
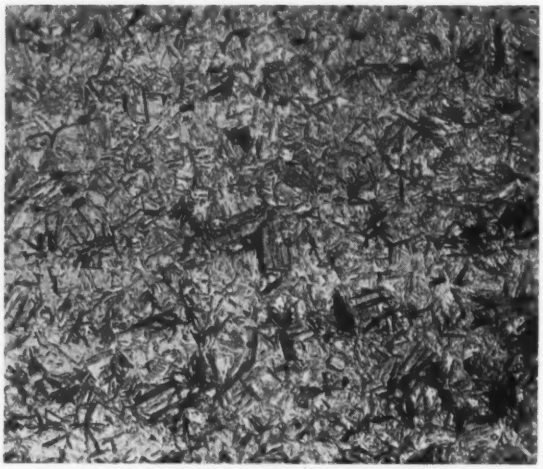


FIG. 2b. (TOP) Isotherm, 900° F.; time at isotherm, 15 seconds; transformed product, upper bainite; percent of transformation, 6.0. (CENTER) Isotherm, 900° F.; time at isotherm, 60 seconds; transformed product, upper bainite; percent of transformation, 27.0. (BOTTOM) Isotherm, 900° F.; time at isotherm, 6 days; transformed product, upper bainite; percent of transformation, 45.0.





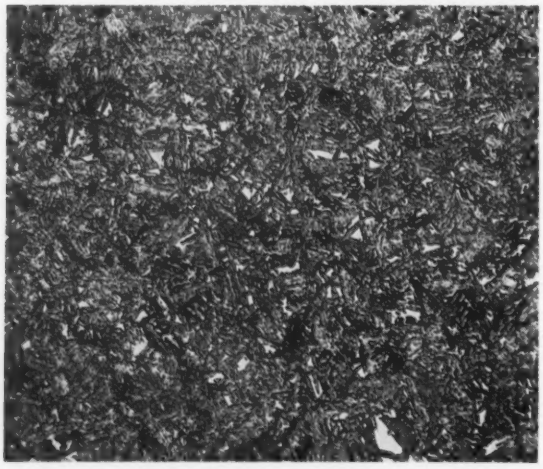


FIG. 2c. (TOP) Isotherm, 700° F.; time of isotherm, 15 seconds; transformed product, lower bainite; percent of transformation, 7.0. (CENTER) Isotherm, 700° F.; time at isotherm, 30 seconds; transformed product lower bainite; percent of transformation, 26.0. (BOTTOM) Isotherm, 700° F.; time at isotherm, 2 minutes; transformed product, lower bainite; percent of transformation, 90.0.

quenching is dependent upon a close control of the entire process. This includes austenitizing temperature and time, atmospheric protection during austenitizing, quench temperature, time of immersion and section size. It is essential that reliable equipment is used where the above controls can be realized. The austenitizing temperature is of importance since this value will determine the austenitic grain size, the degree of homogenization and the extent of carbide solution. It is essential that prior structure of the material marquenched be similar so that this variable will not influence the end result. The use of a protective atmosphere or a salt bath during the heating cycle has been cited[1,2] since any scale that may form will subsequently act as a barrier for uniform quenching.

In regard to the temperature used for quenching, this value is usually slightly above the Ms point. However, in order to obtain greater cooling power, the temperature of the bath can be held at or slightly below the Ms point. The transformation to martensite will take place quite slowly at even 25 to 50° below the Ms so that it usually is not harmful if the transformation has started prior to the removal of the work from the bath.

Although the salt bath is the customary quenching medium for martempering, the use of high temperature quenching oil can also be employed. In marquenching the nitrates and nitrites of the alkali metals are the salts employed and at the temperatures of 350 to 1,100° F. they are capable of flowing as freely as water and can be mechanically agitated or pumped through nozzles or apertures in fixtures to effect forced jet quenching. In a specific mar-temp oil, a flash point of 530° F. is given and claims are made that it will retain its effectiveness over long periods if adequate heat control is maintained to keep the bath temperature below 450° F. Marshall[4] has cited a marquench oil that is used in hot quenching of transmission gears, shifter rails and trunniens that are case carburized, and bushings and hinge pins that are carbonitrided—all these parts being used as tractor shovel parts. This oil, which is operated at 300° F., has a flash-point of 353° F., a fire-point of 600 to 625° F. and a viscosity of 120 SSu at 210° F. The oil is checked monthly for sludge, viscosity and any evidence of deterioration or breakdown.

Regardless of whether molten salt or hot oil is used, it is essential that sufficient agitation be provided that a uniform quench is realized. It is also essential that sufficient volume of quenching medium is available in relationship to the quantity of work that enters the quenching bath. In instances where an oil is used, the oil is frequently fortified with a wetting agent to increase quenching speeds and anti-oxidants which promote stability over long periods at elevated temperatures. The addition of water to the nitrate-nitrite salt bath will increase the quenching power as well as lowering the freezing point of the salt;[5,6] this being added by

directing a stream of water through a small ½ in. tube at the vortex of salt around the pump or mixer shaft. It is stated[8] that the turbulence of the salt carries the water into the bath without spattering or hazard to operating personnel. At 400° F., for example, an addition of 1 to 2% water would evaporate in less than 24 hours. This makes it necessary to make periodic additions during the operation of the furnace. Case and White[8] point out the well-known hazard in adding water to hot salt and recommend the addition of water to a bath only when the temperature is below 350° F. while the bath is well stirred.

The holding time in the quench bath should be sufficient to realize equalization of the temperature gradient throughout the entire section. A general rule is that the time period should be between 3 and 5 minutes per every ¼ in. of the maximum section thickness. Where thin and thick sections are to be quenched simultaneously, the time value for the heavier section should be considered.

The rate of cooling from the marquench bath to room temperature should be conducted in still air; this being particularly true of those compositions that are sensitive to cracking during martensitic transformation. The procedure of transferring parts from a salt pot directly into hot water for the removal of residual salt should be discouraged. This frequently leads to breakage in some of the higher carbon steels. It has been further stated by Aborn[1] that on a few analyses, particularly the high carbon, high alloy types of heavy section, cooling in either a furnace or in ashes is advisable to avoid cracking.

As previously stated, the temperature employed for quenching is dependent upon the chemical analysis of the material. Figure 5 gives Ms values for 14 carbon and low alloy steels. In an explanation of this chart, Aborn[1] has indicated two trends: "First and most obvious, is the influence of carbon; with increasing carbon content the martensitic range widens and is displaced to lower temperatures. Secondly, the martensitic range of triple alloy compositions, such as a chromium-nickel-molybdenum analysis, is usually lower than that

FIG. 3. Schematic chart illustrating relationship of the quench and temper type of hardening treatment to a typical IT diagram. The end product is tempered martensite.[6]

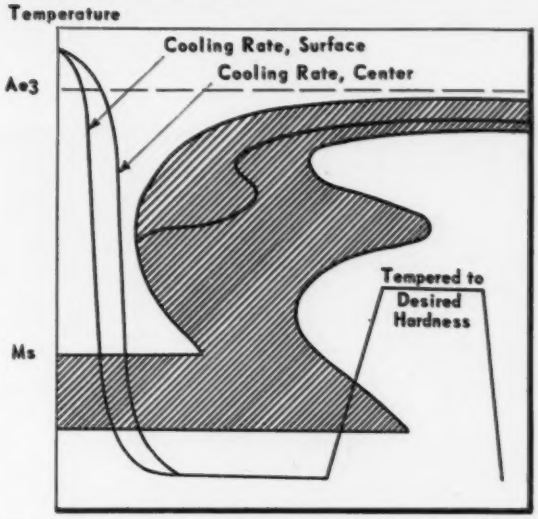


FIG. 4. Schematic chart illustrating relationship of marquenching to a typical IT diagram. The end product is tempered martensite.[6]

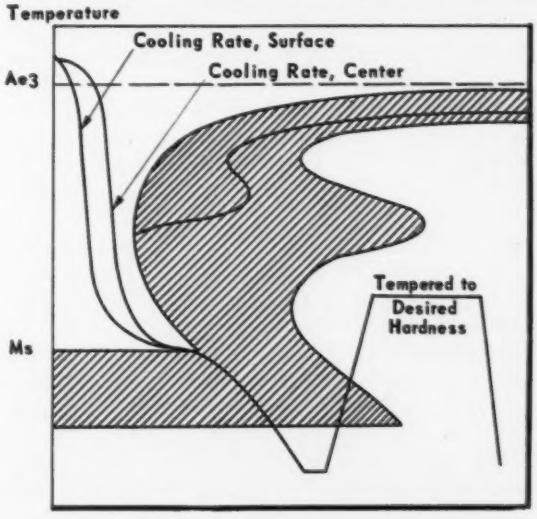


TABLE 1. Comparison of Martempering, Oil Quenching and Water Quenching of 4150 and 52100 Steels (R. A. Grange and K. G. Carroll cited by Reference 1).

D = 1 INCH FOR 4150
D = ⅞ INCHES FOR 52100

60° NOTCH, 0.09 INCHES DEEP, 0.01 INCH RADIUS AT BASE.

Steel	Treatment***	Surface Hardness, Rockwell C	Surface Structure	Surface Retained Austenite**	Center Hardness, Rockwell C	Center Structure	Center Retained Austenite
4150	Martempered	60	99 M, Tr. B	None	58	99 M, 1 B	None
4150	Oil Quenched	61	100M	5%	59	100 M	5%
4150	Brine Quenched	65	100M	None	61	100 M	None
52100	Martempered	64	90M, 10 B	None	55	80 M, 20 B	None
52100	Oil Quenched	66	99 M, Tr. B	5%	65	99 M, 1 B	5%
52100	Brine Quenched	66	100M*	None	66	100 M	None

*Specimen cracked; M = Martensite, B = Upper Bainite.
**This method used may not indicate the presence of austenite with certainty when less than 2% is present.
***Martempering in salt at 450° F. for 5 minutes, then cooled in air. Oil quenching in oil at 170° F. Brine quenching in brine at 80° F. Austenitizing at 1,550° F. for 1 hour. All quenching baths agitated vigorously.

TABLE 2. Distortion and Growth Data on Tractor Shovel Parts After Carburizing.[4]

Gears—4 to 9.5 in. pitch diameter			
MARQUENCHED			
Involute Error, Maximum	0.0003 in.		
Total Tooth Spacing Error, Maximum	0.0005 in.		
Bore Shrinkage	0.0005/0.0010 in.		
Lead Error, Maximum	0.0003 in.		
Bushings—2,385 O.D. x 2.031 I.D. x 1.75 inches long; SAE 1025			
MARQUENCHED			
O.D. Growth	0.003 in.		
I.D. Growth	0.002 in.		
Out of Round	0.0015 in.		
Splined Shaft—19 inches long x 2.0 inches in Diameter; SAE 8620			
MARQUENCHED			
Camber	0.003 in.		
Spacing	0.0015 in.		
Shifter Rails—1.0 inches in Diameter; SAE 1411			
	Standard Quench Oil at 140F	Marquenched Oil at 300F	
10 in. long—Camber	.012-016. in.	.003 in. max.	
14 in. long—Camber	.018-.026 in.	.005 in. max.	
Couplings—2.75 inches long x 1.562 inches O.D. x 0.75 inches I.D.; SAE 1025			
I.D Growth .006-.009 in.	I.D. Shrink .001-.002 in.		
Out of Round .003-.005 in.	Out of Round .0005 in.		

of a single or double alloy steel of corresponding carbon content."

As with any other heat treatment, martempering is limited. The material chosen must usually contain some alloy or sufficient carbon to insure that the beginning of transformation to martensite is slowed down. Where it is desired to heat treat a carbon steel by this method, there is a limitation as to thickness, this being dependent upon the carbon content. A carbon steel containing 0.60% carbon has less than one minute of total time available before transformation starts at 550° F. This indicates that for lower carbon steels, as well as some alloy steels, there may be insufficient time in transfer of the material from furnace to hot oil. It should be remembered that retardation of transformation should be sufficient to permit an austenitized structure up to the Ms temperature at which time it enters the hot oil or salt bath.

The alloy carburizing steels respond quite satisfactorily to the marquenching process. The material being carburized to the required case depth and subsequently quenched in hot oil or molten salt. This procedure has realized such advantages as less deformation, less retained austenite and a cleaner surface provided atmosphere protection has been given in event that a steel has had a reheat. It has also been stated[3] that this procedure is economical since a long diffusion cycle after gas carburizing as well as difficult cleaning operations could be eliminated.

Marshall[4] has cited the carburizing of AISI 8622H and 6120 to a case depth of 0.044 to 0.052 in. and marquenched to a hardness of Rockwell C62 to 65; the items carburized being transmission gears, shafts, trunniens, etc., used on tractor shovel parts. After a total carburizing time of 6 hours at 1,700° F., the parts are immersed in a quenching oil that is at 300° F. and held at this temperature for 5 minutes. Subsequent tempering at 340 to 375° F. for 1½ hours results in a working hardness of Rockwell C58 to 62. This procedure has reduced distortion to a point where die and fixture quenching could be eliminated on all production including large gears. Distortion and growth data for these marquenched parts are given in table 2.

Another application of a carburizing-marquenching procedure is the outboard motor crankshaft that is racked in a fixture with the entire cycle automatic. The charging end of this conveyorized set-up is illustrated in figure 6. This cycle includes: (1) carburizing for 2 hours 40 minutes at 1,760° F. to obtain a case depth of 0.035 to 0.040 inches; (2) immersion in a neutralizing wash bath for 7 minutes operating at 1,450° F.; (3) quenching in hot salt at 400° F. for a period of 7 minutes; and, (4) salt tempering at 450° F. for 2 hours 20 minutes to obtain a final hardness of Rockwell C58 to 60.° The compositions employed include SAE 4615, 3120 and occasionally 4620 and 8617. The shaft weight is 2¼ lb.

Another popular application is that of ball bearing races; the conveyorized installation is illustrated in figure 7. SAE 52100 is generally used and bearings 1¼ in. section size and more are being marquenched commercially. Solid armor piercing shot of 3½ in. diameter and alloy steel castings nearly 6 in. thick are

TABLE 3. Data on a Few Tool Steels that have been Martempered.

Steel Type	Chemical Composition Percent C	Mn	Si	Cr	W	Mo	V	Ni	Austenitizing Temperature F.	Ms	Transformation Data, degrees F. 20%	40%	50%	80%	90%	95%	100%
1	0.60	0.70	1.85	.....	.....	0.45	0.20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	0.50	.....	0.75	1.15	2.50	.....	0.20	.....	1750	600	.....	.....	.....	450	.....	220	.....
3	0.60	0.90	2.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4	0.45	0.55	.....	0.95	.....	.....	0.20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
5	0.90	1.20	.....	0.50	0.50	.....	0.20	.....	1450	390	.....	350	.....	300	.....	200	.....
6	0.75	0.75	.....	0.50	.....	0.35	.....	1.75	1550	425	.....	320	300	.....	.....	150	.....
7	0.30	.....	1.00	5.00	1.25	1.35	.....	.....	1850	530	500	.....	.....	400	300	200	100
8	0.40	.....	1.05	5.00	.....	1.35	0.35	.....	1850	520	400	.....	.....	300	.....	200	.....
9	0.28	.....	1.05	3.25	9.00	.....	0.25	.....	2100	730	.....	.....	.....	.....	.....	.....	520
10	0.40	.....	1.05	5.00	.....	1.35	0.35	.....	1850	520	400	.....	.....	300	.....	200	.....
11	0.40	.....	1.05	5.00	.....	1.35	1.10	.....	1850	520	400	.....	.....	300	.....	200	.....
12	0.30	0.75	0.50	0.80	.....	0.25	.....	.....	1550	860	.....	.....	.....	.....	.....	.....	200

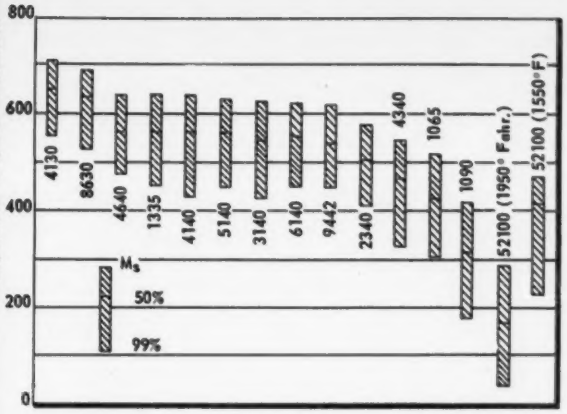


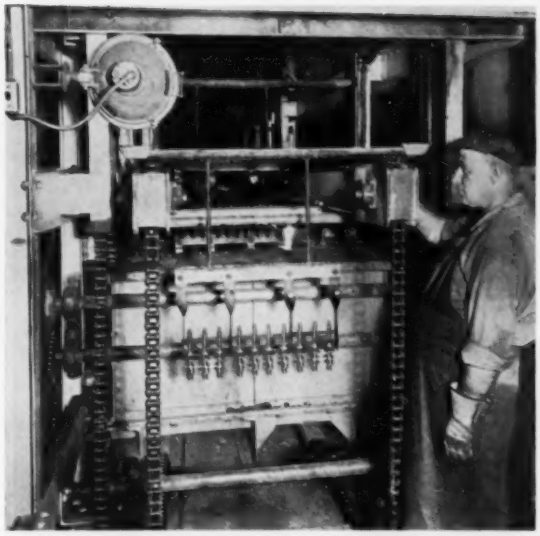
FIG. 5. Temperature range of martensite formation is 14 carbon and low alloy steels (R. A. Grange and H. M. Stewart) Quoted by Reference 1.

also typical marquenched items. Another application is in the heat treatment of the alloy tool steels, particularly on such compositions as the manganese oil hardening and some shock resisting types. This process is usually more applicable to small sections and is recommended where the repetitive nature of the work will permit the development of a practical heat treat procedure. Some of the tool steels that respond to a marquench treatment are listed in table 3.

If a marquenching procedure is employed on tool steels having a section size that would respond satisfactorily, the following procedure is recommended[10]: (1) heat to the austenitizing temperature; (2) quench in either hot salt or oil at 400 to 425° F.; where the Ms temperature is on the high side, as exemplified in steels 9 and 12, a salt bath is employed; (3) removal from the hot quench bath followed by air cooling to about 150° F.; and, (4) temper immediately to the desired hardness. It has also been stated that any section size which cannot be adequately cooled in 10 minutes should not be marquenched.

Ajax Electric Company has given an interesting cycle in marquenching a high manganese oil hardening steel that has been made into punches and dies. The treatment consisted of (1) preheating at 1,300° F. for 20 minutes; (2) transfer to the hardening furnace at 1,440° F.; (3) quench 50° F. below the Ms in hot salt containing 2 to 4% water with the holding period being 10 minutes; (4) cool in still air; and, (5) temper at 325 to 350° F. to the desired hardness. Where the design is rather complicated, it is advised that the punch be placed in the mating die that has been heated to 200° F. and the pair then air cooled to room temperature. As the punch and die combination cools, the punch becomes wedged tightly in the die cavity. This controls distortion and expansion almost 100%. In the tempering process, the necessary shrinkage of the punch is realized to permit easy removal of the punch from the die.

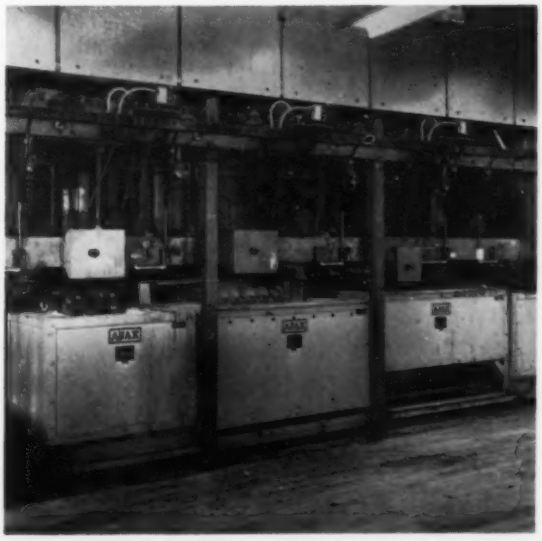
Austempering. This is a hardening process that is



Courtesy Ajax Electric

FIG. 6. Charging end of conveyorized electric salt bath carburizing furnace with ten outboard motor crankshafts racked in fixture ready to start on automatic heat treat cycle.

FIG. 7. Martempering ball bearing races (SAE 52100) in a Jack-rabbit type mechanized salt bath.



Courtesy Ajax Electric

based on the isothermal transformation of austenite to bainite. This type of treatment, which is illustrated schematically in figure 8, consists of austenitizing, quenching to temperature above the Ms point within the lower bainite range, held at this temperature for a sufficient length of time to obtain complete transformation and then air cooling. Depending upon the transformational characteristics of the steel involved, the temperature range at which lower bainite will form may be from 500 to 700° F. Since this transformation occurs at a relatively high temperature and proceeds rather slowly at the selected isotherm, the stress level after transformation is rather low and distortion is held to a minimum.

The austempered hardness will vary in accordance to the isotherm that is selected. As the transformation of the austenite to bainite reaction approaches the Ms temperature, the harder will be the "as quenched" hardness. As in marquenching, a prerequisite is that the steel contain some alloy to slow down the beginning of transformation. Carbon steels, in which the carbon content is 0.60% and over, are usually limited to thin sections to realize response to an austempering treatment.

Mehrkam[8] mentions both the two-step and three-step austempering cycle; the former procedure being the standard austenitization followed by direct quenching in hot salt at the selected isotherm. The three-step method is a modification in that a lower quench temperature is used to increase the rate of cooling. The work is then transferred to a draw furnace, which is operating at a higher temperature, to complete the

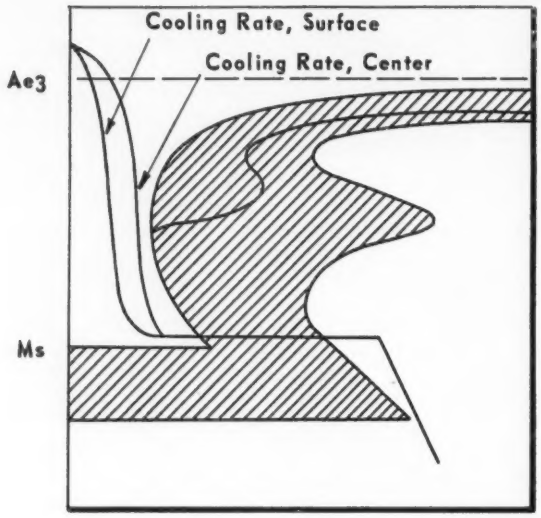


FIG. 8. Schematic chart illustrating relationship of austempering to a typical IT diagram. The end product is bainite.[6]

TABLE 4. Examples of Short Time Annealing Cycles Based on Isothermal Transformation.[3]

Grade	Approximate Composition, Percent								Austenitizing		Transformation		B.H.N.
	C	Mn	Si	Ni	Cr	Mo	W	V	Deg. F.	Time Hours	Deg. F.	Time Hours	After Anneal
Maxel 3½	0.50	1.00	0.20	.....	0.50	0.15	.....	.....	1390	2	1300	4	179/197
4042	0.45	0.90	0.25	.....	.....	0.25	.....	.....	1500	2	1250	2	179
8620, 8720	0.18	0.85	0.20	0.55	0.50	0.25	.....	.....	1600	1	1250	2	143
4132-4160	0.30 to 0.60	0.85	0.25	.....	1.00	0.25	.....	.....	1425	2	1300	2	170/192
3130-3150	0.30 0.50	0.80	0.25	1.20	0.70	.....	.....	.....	1425	2	1250	2	163/174
3240	0.45	0.50	0.25	1.80	1.00	.....	.....	.....	1425	2	1260	2	187/192
4320-4342	0.20 to 0.45	0.70	0.25	1.80	0.80	0.25	.....	.....	1425	2	1210	8	163/235
4640	0.40	0.70	0.25	1.80	.....	0.25	.....	.....	1370	2	1210	12	187
6150	0.50	0.80	0.25	1.00	.....	.....	.....	0.20	1425	2	1310	4	192
9260	0.60	0.90	2.00	.....	.....	.....	.....	.....	1450	2	1360	4	212
Tool Steel	0.80 to 1.20	0.25	0.25	.....	.....	.....	.....	.....	1410	2	1330	3	174/187
52100	1.05	0.30	0.25	.....	1.40	.....	.....	.....	1440	4	1340	4	197/207
High C, High Cr	1.50	0.25	0.40	.....	11.5	0.50	.....	0.25	1700	2	1430	4	223
High Speed	0.75	0.30	0.30	.....	4.00	.....	18.0	1.00	1650	2	1400	4	255
High Speed	0.85	0.30	0.30	.....	4.00	4.50	5.50	1.30	1650	2	1400	4	217
Lo Cro 46 Mo	0.10	0.40	0.30	.....	4.50	0.50	.....	.....	1550	2	1390	2	134/143
Stainless	0.10	0.40	0.25	.....	12.0	.....	.....	.....	1650	2	1310	3	137/152
Stainless	0.60 to 1.00	0.30	0.25	.....	16.5	.....	.....	.....	Preheat 1400, 1650	2 2	1370	3	197/248

transformation to higher temperature bainite. The basic advantage of this method is the utilization of the high quenching power of a comparatively low temperature quench, and yet transforming the structure to a tough bainitic structure.

Austempering is usually used for small, thin parts where the hardness requirement is between Rockwell C35 and C50 and where toughness, or, the ability to bend without breaking is a requirement. Typical applications would include shoe shanks, typewriter parts, electric shaver blades, springs, sewing machine parts, automobile bumpers, open end and socket wrenches, pliers, lawn mower blades and small gears.

Specific examples of austempering cycles would include lawn mower blades made from AISI 1065. The blades are heated in salt at 1,550° F. for 6 minutes, quenching in hot salt at 475° F. for a 6 minute hold period, air cooled and washed. The resultant hardness is Rockwell C48 to C52. Another example is that of cast iron cylinder liners[18] austempered to a hardness of Rockwell C45 to C55. The cycle consists of a pre-heat at 1,440° F., austenitized at 1,580° F., isothermal quenched at 400° F., drawn at 425° F., air cooled and washed. A cycle of a low chromium boron type steel, AISI 50B44, consists of austenitizing at 1,550° F. for 15 minutes, quenching in hot salt at 500° F. for 15 minutes, tempered at 800° F. for 30 minutes, washed and rinsed. This entire cycle is performed on automatic "jack rabbit" type of salt bath furnace with the total time being at 75 minutes. The final hardness of this material, which was made into adjustable wrench bodies, was at Rockwell C49.

In regard to the quenching medium employed, the same precautions as to agitation, sufficient volume of quenching medium in relation to the mass of material quenched, etc. that were discussed under marquenching are equally true for austempering operations.

Cyclic Annealing. Fundamentally, an annealing treatment has as its prime purpose the softening of a steel which can be achieved in several ways. However, in many instances, a specific treatment is required to obtain other characteristics. The standard annealing practice, which is schematically illustrated in figure 9, consists of austenitizing at a temperature above the Ac_3 temperature followed by a controlled cooling which is sufficiently slow to produce the desired structure of ferrite and pearlite. The term "controlled cooling" may mean instrument control at a predetermined rate in degrees per hour, or it may mean the cooling of a charge within the furnace at a rate which is characteristic for the specific furnace with a known load. This cycle is most frequently used either to produce a certain microstructure, hardness, or a combination of both.

This type of anneal is often termed a "recrystallization" treatment as compared to the stress relief anneal that is performed at some sub-critical temperature, usually below the Ac_1 temperature. As its name implies, this type of treatment is used to relieve stresses that have been realized during cold work. The rate of

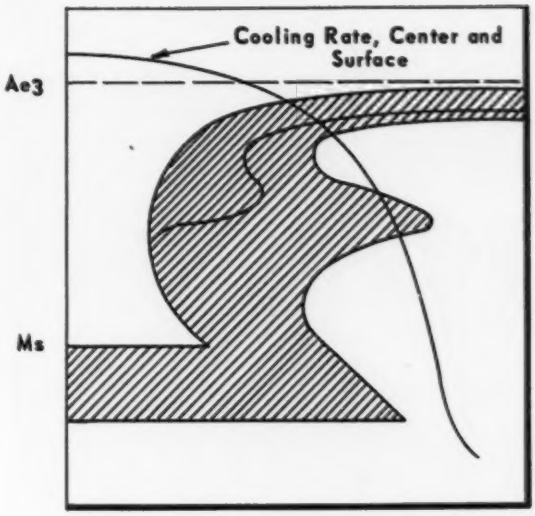


FIG. 9. Schematic chart illustrating relationship of the conventional annealing cycle to a typical IT diagram. The end product is ferrite and pearlite.[6]

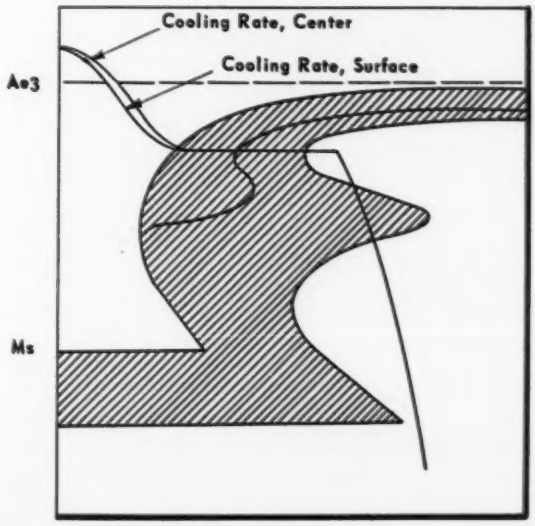


FIG. 10. Schematic chart illustrating relationship of isothermal annealing cycle to a typical IT diagram. The end product is ferrite and pearlite.[6]

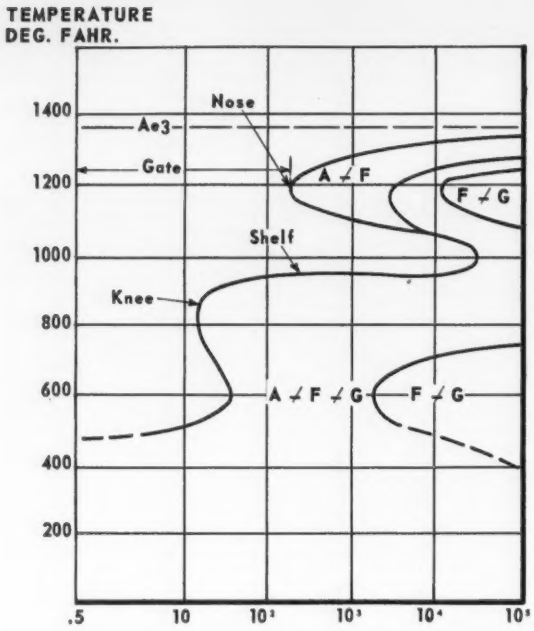


FIG. 11. Isothermal Transformation Diagram for 4340 (15)

cooling from this sub-critical temperature has practically no effect on either the hardness or the microstructure since no metallurgical change occurs during the cooling phase.

However, in some instances, particularly with medium to high carbon alloy steels, the conventional recrystallization anneal is not very satisfactory due to the necessity of obtaining either a partial or full spheroidization of the carbides for the purpose of machinability. This had led to the development of an anneal which consisted of heat to a temperature just below the lower critical point (Ae_1) which resulted in a very satisfactory spheroidal structure. This type of treatment is essentially an isothermal annealing treatment, although at the time of its development, the mechanism of isothermal transformation was not completely understood.

Upon introduction of the isothermal diagram, which resulted in the production of diagrams of many types of steels, it was observed that there was a pronounced minimum in the "end of transformation" at relatively high temperatures in many of the existing diagrams. On the assumption that the transformed product at this temperature is satisfactory, advantage may be taken of this fact in the design of a short annealing cycle. This was particularly attractive since at that time the standard annealing cycle for many medium and high allow steels was quite long due to the necessity for rather slow, controlled cooling rates employed to obtain either the desired microstructure or hardness. This short annealing cycle became a reality for many types of steels and the procedure employed, which is schematically illustrated in figure 10, consisted of heating to a pre-determined austenitizing temperature followed by a rapid cooling to the desired isotherm in which the austenite transformed to a combination of ferrite and pearlite. The rate of cooling after transformation had been completed was not of importance.

As in any other operational heat treatment, success of the annealing treatment was dependent on the selection of a proper temperature to obtain austenite and the transformation to the desired microstructure in a minimum of time. The more carefully these two factors were controlled, the more successful would be the annealing treatment. In considering the relationship of these two factors to microstructure, a series of rules has been formulated by Payson[3] which should be observed when planning an isothermal annealing treatment. These rules can be given briefly, thus:

1. The higher the austenitizing temperature, the greater is the tendency for the structure of the annealed steel to be lamellar, whereas, the closer the austenitizing temperature is to the critical temperature, the greater is the tendency for the structure of the annealed steel to be spheroidal.

2. To develop the softest condition in steel, austenitize at a temperature usually less than 100° F. over the critical, and transform at a temperature usually less than 100° F. below the critical.

3. Since the time for complete transformation at temperatures less than 100° F. below the critical may be quite long, allow most of the transformation to take place at the higher temperature where a soft product is formed. Complete the transformation at a lower temperature where the time for completion of transformation is short.

4. After the steel has been austenitized, cool as rapidly as feasible to the transformation temperature in order to decrease the total time of the annealing operation.

5. After transformation has been completed, cool as

TABLE 5. Typical cycles.[16]

Typical Steels	Cycle A 8620, 4620	Cycle B 4817, 4820
Zone 1—Heating	Heat from cold to 1750° F. in 3 hours.	Heat from cold to 1750° F. in 3 hours.
Zone 2—Holding	Soak at 1750° F. for 2.33 hours.	Soak at 1750° F. for 2.33 hours.
Zone 3—Superfast Cool	Cool from 1750 to 1300° F. in 20 to 30 minutes. Hold for remainder of pushing cycle.	By Pass
Zone 4—Fast Cooling	Cool from 1300 to 1200° F. in 3 hours.	Cool from 1,700 to 1,100° F. in 2 hours.
Zone 5—Slow Cooling	Cool from 1200 to 900° F. or lower in 5 hours.	Cool from 1100 to 600° F. in 6 hours.
Total Time	14 hours	13.33 hours

rapidly as possible in order to decrease the time of the annealing operation.

6. In hypoeutectoid steels, as well as other low alloy, medium carbon steels, preheat the steel for several hours at a temperature about 50° F. below the critical prior to austenitization and proceed as per usual. This will assure a minimum of lamellar pearlite in the structure of the annealed material.

7. To obtain a minimum hardness in annealed hypereutectoid alloy tool steels, heat the steel for a long time, about 10 to 15 hours, at the austenitizing temperature, and transform as usual.

In the establishment of a cyclic annealing treatment, it should be sufficiently broad to cover the variations that are found in commercial heats of the same material; this may require some experimentation as was the case in obtaining an annealing treatment for Rex AA tool steel.[8] Thus, on the basis of experimentation in obtaining a maximum 241 Brinell on this material, the following cycle was recommended: (1) austenitize at 1,650° F.; (2) reduce temperature as quickly as possible to 1,470° F. and hold 3 hours; (3) lower the temperature to 1,450° F. and hold for 3 hours; (4) cool in furnace to 1,425° F.; and, (5) finish cool in air. As a result of Payson's work,[8] table 4 is given which includes alloy constructional steels of different compositions, tool steels and hardenable stainless. The basis on which these cycles were established was the minimum time to produce a structure that is of a reasonable hardness level — about 200 Brinell.

Relatively few heat treating plants have the proper equipment to permit a rapid cool of an annealing charge from the austenitizing temperature to the selected isotherm where transformation to the desired structure occurs. In addition, other difficulties such as furnace construction, method of heating or an inadequacy of control equipment may be present. Even though these variables may influence a heat treater to forget isothermal annealing, it still may be possible to employ a modified isothermal technique even with rudimentary equipment and still obtain a product within the desired reasonable hardness level — about 200 Brinell.

As an example, Republic[15] has presented the following problem in the isothermal annealing of SAE 4340 in a furnace that may have a 50° F. differential between the indicated furnace temperature and the coldest portion of the load. The desired maximum hardness is at 223 Brinell. According to figure 11, the effective transformation range lies between 1,250° and 1,100° F. with the time at 3 and 14 hours respectively. The time during which the load is above 1,250° F. can be disregarded since very little effective transformation occurs above this temperature. Likewise, austenite that may exist below 1,100° F. will remain untransformed almost indefinitely. Thus, it is essential to have every portion of the load through the range of 1,250° and 1,100° F. Although the diagram indicates that if the load was held at 1,200° F. for a minimum of 3 hours, transformation would be complete, in commercial practice, to provide a safety factor, the time should be at least twice that of the minimum time, which in this case would be 6 hours.

After the charge has been austenitized at 1,425° F., it is cooled to 1,275° F. and held until the load has equalized in temperature. At this point, under the conditions of this example, the true furnace temperature could be 1,300° F and the minimum temperature of the load at 1,250° F. According to the diagram, all portions of the load should by this time begin to transform. By the time the charge has been cooled to and equalized at 1,275° F. more than two hours have elapsed. It is now safe to assume that austenitic transformation is progressing in all parts of the load and after the required time at the isotherm, which is a minimum of 6 hours, even though a drop of temperature of 20° per hour is experienced over this minimum holding time, it still will be within the range for isothermal transformation to the desired structure. Resulting hardness will be approximately 200 Brinell.

SAE 4800 series compositions have completion curves lying so far out of the time scale that these types are commercially uneconomical to anneal by conventional methods. They can, however, be annealed[15] to a reasonable machining hardness with the use of the isothermal curves. Thus, as indicated by the isothermal curves, transformation will proceed quite rapidly just below the knee of the curve. The temperature at this point is about 800° F. If the steel is quenched at this isotherm and held for the specified time for complete transformation, the resultant hardness will be roughly between 300 and 400 Brinell. If, however, after transformation at 800° F. is complete or almost completed, the temperature of the steel is raised to 1,200° F., coalescence and spheroidization of carbides will begin immediately. This spheroidization treatment, which should not be developed at temperatures higher than 1,200° F., will give a satisfactory machining hardness.[15] The time variance, from 12 to 24 hours, depends upon the specific requirements.

Where isothermal annealing is contemplated, special furnace designs are recommended. Alban and Bates[14] have disclosed such an installation in which a zoned roller rail, continuous furnace is used for annealing gear forgings of a wide range of sizes and shapes. Typical annealing cycles are given in table 5. Residual heat of forgings as they come from either the press or hammer is used to advantage. These hot forgings, which are still above the upper critical temperature, are quenched in agitated salt at a subcritical temperature which may vary from 1,150 to 1,250° F., and, after a comparatively short time, transformation to the desired structure is realized. The forgings are then water quenched to remove the scale. To obtain a relatively soft, uniform structure, it is essential that the forging be of simple design to assure that all parts are

Concluded on page 44

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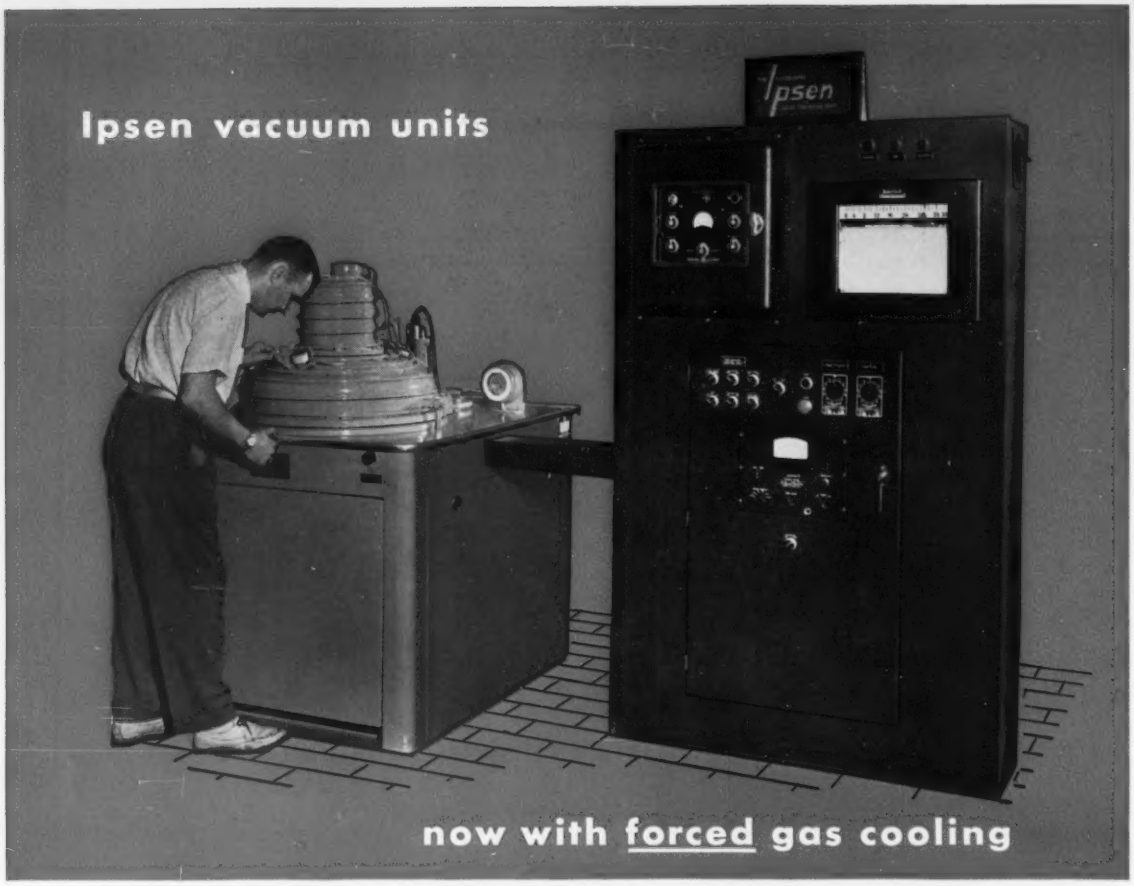

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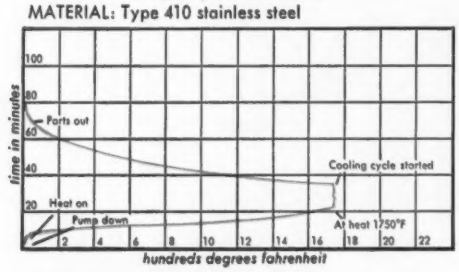
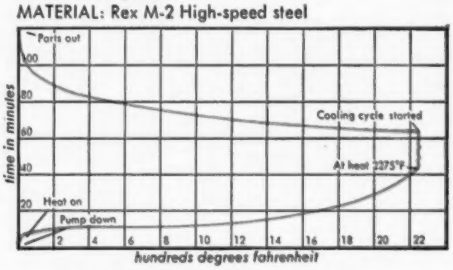
MATERIAL: Type 410 stainless steel



COMPLETE TIME CYCLE: 1 hour 8 min.
RESULTS: Rockwell C 42-43
APPEARANCE: Exceptionally bright

PARTS: Boring bars
MATERIAL: Rex M-2 High-speed steel



COMPLETE TIME CYCLE: 2 hours 10 min.
RESULTS: Rockwell C 64-66
APPEARANCE: Exceptionally bright

A complete line of standard vacuum units is available. Also, vacuum facilities are available in which processing, testing, and analysis can be made to recommend the proper equipment for your parts. For detailed information contact Ipsen Industries, Inc.

AUTOMATIC Ipsen HEAT TREATING UNITS

IPSEN INDUSTRIES, INC. • 733 SOUTH MAIN STREET • ROCKFORD, ILLINOIS

For further information circle No. 5

A NEW METHOD FOR BRAZING

ALUMINUM AND MAGNESIUM

CASE REPORT

WALLACE C. RUDD
Vice President, Engineering
New Rochelle Tool Corporation
New Rochelle, New York

FOR MANY YEARS, in the high temperature brazing of aluminum and magnesium, there has existed a problem in that the brazing alloy melts very close to the melting point of the parent metal. Aluminum and magnesium alloys melt close to 1,200 F. In most cases a temperature differential of only 100 F. or less exists between the brazing alloy and the materials to be brazed. This introduces a very severe problem in temperature control in order to obtain satisfactory flow of the alloy with no damage to the metals being bonded.

In order to perform such a braze, it has been customary in the past to use very closely controlled furnaces or very highly skilled operators. In torch brazing work, the operator has no signal other than considerable skill in determining when he is near the melting point of the parent metal. These materials, at the brazing temperature, give no noticeable color indications in normal light.

Furnace brazing has been the basic method used to perform aluminum and magnesium brazes; however many drawbacks are present, several of these being that the furnace is large, the initial cost is high, the operating cost is high and the entire work piece heated. One other method of brazing has been used on occasion, and this is induction heating. However, this has never attained acceptance because of the difficulty of obtaining complete uniformity of temperature in the brazed area.

With the foregoing facts in mind, the New Rochelle Tool Corporation of New Rochelle, New York, has developed a complete new and unique type of heat source for brazing metals in which very close temperature control is required. Usually close temperature control implies a low rate of power input to the object. It is uncommon to have very accurate temperature control and very high rates of power input to the work being brazed.

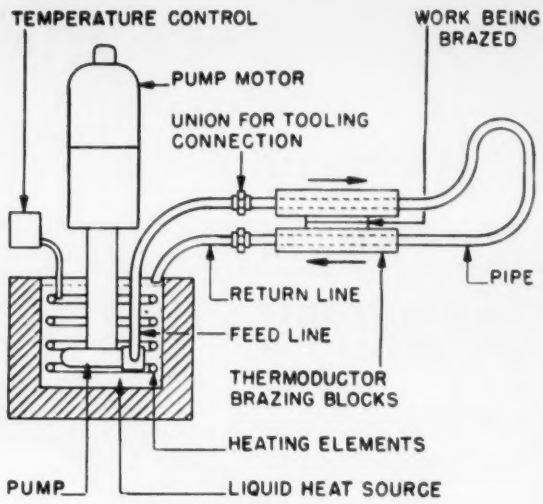
With this new method these two important factors are combined, giving a source of heat which is accurate in temperature (on the order of plus or minus 5 F.), and with which high rates of power input to the material being brazed can be realized. This new method is fully covered by patents.

Fundamentally the so-called Thermoduction method consists in the pumping of heated liquids through metal dies, designed for the particular application, which contact the work being brazed. A schematic drawing of a typical unit is shown in figure 1. The basic heat source, which might be called a heat sump, is an electrically heated tank which is thoroughly insulated. The temperature of a liquid in the tank is held to a close pre-set value; a typical working temperature for aluminum would be 1,170 F. plus or minus 5 F. Temperature control of the liquid is by conventional thermocouple instruments controlling the electric power input. Mounted in the tank of liquid (which shows a dull red heat) is a specially built water-cooled centrifugal pump which will pump the liquid out of the tank into stainless steel or similar metal pipes which carry the liquid to blocks of Inconel or other suitable material. The liquid passes through the blocks and then returns to the tank.

The flow is at a rate of 5 to 50 GPM and, with a liquid with a specific heat of 0.2 and a density on the order of 100 pounds per cubic foot, a high rate of energy is brought to the metal blocks from which it is to be transferred to the work piece. These metal blocks are called Thermoductor blocks. With the liquid circulating through the piping and blocks, the whole system is at very accurate temperature and anything that is brought into contact with the blocks can extract heat from them without any possibility of having an over-temperature condition exist. Since both aluminum and magnesium are very good thermal conductors, heat flow from the Thermoductor block to the aluminum, and through the aluminum to the brazing alloy is good.

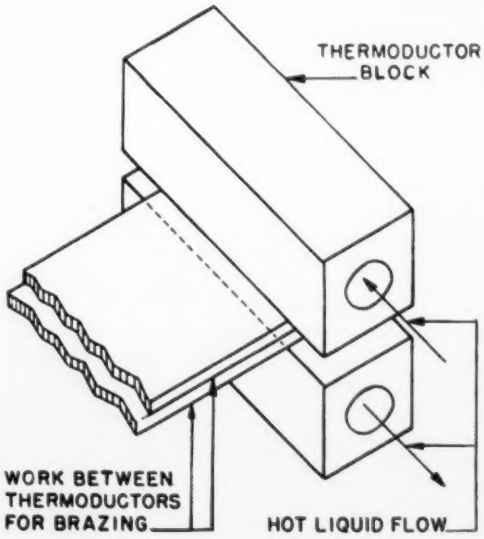
In a typical operation where a lap joint is to be considered, the joint is prepared in the usual way by coating with brazing flux and placing a shim of brazing alloy in place, or using commercially available sheet already coated with brazing alloy. The two pieces to be brazed are placed between the two heated blocks, which can be shaped to suit any special contours of the object. Figure 2 shows a lap joint in position for brazing. The two blocks are brought together with light pressure on the aluminum. On 16-gauge aluminum the braze takes place in less than 30 seconds. After the alloy has flowed, the blocks are raised slightly and the work removed. With flow rates on the order of 5 to 50 GPM, there is an insignificant temperature differential between the liquid entering the system and that returning to the tank; this of course makes for excellent temperature control with high rates of heat transfer.

A brazing unit of this type can be used to deliver quick shots of high power to a large braze area with a



THERMODUCTION BRAZING UNIT FOR ALUMINUM OR MAGNESIUM

Fig. 1 - Pumped Liquid Brazing Unit for Aluminum or Magnesium.



THERMODUCTORS FOR LAP JOINT BRAZE

Fig. 2 - Heat Transfer Blocks for Lap Joint Braze.

low average power input since the tank can store large quantities of heat between brazes. This might be likened to a tank of water which is being filled with a trickle, but from which large quantities of water can be dumped periodically.

Work Removal

In handling the work, in many cases it is permissible to remove the object with the brazing alloy in the liquid state and let it solidify after removal. In other cases, it is essential that the object be removed from the blocks with the alloy in a solid state. This usually is reasonably easy to accomplish by having a set of water-cooled chill blocks immediately adjacent to the heated blocks. These are shown in figure 3. With the Thermoductor blocks in contact with the object, and the alloy in a liquid state, the chill blocks are brought against the work. Aluminum having a high thermal conductivity, a very small temperature drop in the joint solidifies the alloy and, in a few seconds, the blocks can be released from the work piece and the object removed with the alloy in a solid state. It is allowed to cool to room temperature in air, and may subsequently have the flux removed by hot water washes or acid dips.

By the use of this method, brazing can be done on a large variety of objects, and in many cases instead of heating the whole object, only the local area to be brazed is heated to brazing temperature. This, of course, produces less distortion and discoloration problems and improves the metallurgy over other methods by reduction of the annealed area.

Typical Operation

The described method is not a cure-all for all types of aluminum or magnesium joints; however, there are a large variety of conventional joints which can be made easily and simply. For example, long straight lapped joints in sheets are an excellent application. It is quite practical to make a ½ in. wide lapped joint in aluminum sheet with a length of 50 feet, the whole braze taking place in less than one minute. In this case there would be multiple pumped sources of heat along the 50-foot length supplying the heat blocks.

Brazing a tube to a sheet is another practical and interesting joint which can be made by the process. In this case a sheet of aluminum, which might be 6 feet long and 2 feet wide, has placed upon it a serpentined ⅜ in. tube. Special formed alloy shim can be placed underneath the tube; the whole is placed between two large flat thermoductor blocks and the blocks brought together with one contacting the lower sheet and the other contacting the top of the tube. There is enough thermal transfer to produce a braze of this type in approximately two minutes. During the brazing operation the tube is held in intimate contact with the sheet and a beautiful fillet is produced between the tube and the sheet.

Circular lapped joints are quite practical. For example, two tubes, one fitting inside the other in the form of a sleeve joint, can be quite easily brazed by having the blocks formed in two semicircles which are brought as a clamp against the object around the outside. The shapes and types of joints are only limited by the ability to form a hollow block and bring it in reasonably intimate contact with the area being brazed.

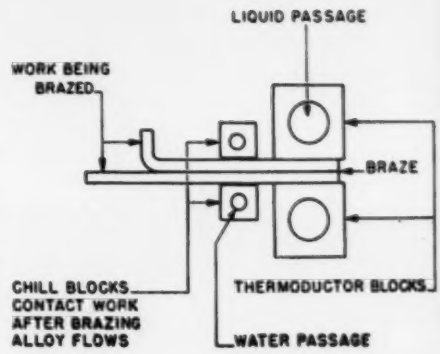


Fig. 3 - Method for Chilling Brazed Joints.

Other typical joints of interest in this field are the brazing of an aluminum sheathed imbedded resistance heater to the bottom of a coffee pot or a deep fat fryer. In this case, a shaped block goes up inside the pot, and a flat heated block is brought against the resistance heater on the outside, the alloy, of course, having been pre-placed. A braze of this type takes approximately one minute and a number can be done at the same time on one pumped heat source.

Equipment

This New Rochelle Tool Corporation equipment is built on the basic philosophy that there should be a general purpose heat source which can be connected to operate a variety of specially tooled Thermoductor blocks and fixtures. The equipment itself is in a cabinet which houses the tank, pump and some of the temperature-control equipment. On the side of the cabinet there are two stainless steel pipe unions to which specially built heating blocks, with their associated piping, can be attached in a relatively short time. The system is heated and the pump started, which passes the liquid through the piping and the blocks. They come to temperature in less than a minute and are then ready for operation. All of the exposed non-working surfaces of the piping and blocks are covered with insulation in order to reduce heat losses and make it comfortable for the operator.

The clamping arrangement which brings the Thermoductor block or blocks into contact with the work, can be manual or air-operated with automatic time control. In arranging the pressure devices, which close the heated blocks, care must be taken to see that excess pressure does not extrude the heated aluminum. This

is most easily accomplished by having mechanical stops which limit the amount of movement in the heating blocks. Pressure applied to the brazed joint should be kept as low as is consistent with having good heat transfer from the block face to the work piece; usually it is only one or two pounds per square inch.

Figure 4 shows an experimental 25 kw unit setup for brazing lap and tube to sheet joints.

Equipment can be built in 25 kw, 50 kw and larger units. The power rating represents the maximum power entering the heat sump. The average power consumption is considerably less than full rating since the thermal losses from the system are minimized by proper insulation. The full power input is utilized during the start-up period and when large quantities of heat are extracted from the brazing blocks.

Work Handling

In handling work a large variety of fixtures are used. For example, in brazing a tube to a sheet, the sheet with pre-placed alloy and tube are assembled on a separate handling sheet. The handling sheet, together with the parts to be brazed, are placed between the heated blocks and the blocks closed. As soon as the alloy is melted and has flowed into place, the upper block is raised and a second cold handling sheet is placed over the serpentined tube which has motel alloy between it and its associated base sheet. The complete sandwich, consisting of an upper hold-down sheet, the two parts being brazed and the lower handling sheet, is then removed from the blocks. The upper hold-down sheet, of course, performs the function of holding the rather lengthy tube in intimate contact with its sheet during the chilling period.

A New Rochelle Tool Corporation 50 kw unit costs approximately one fourth of the equivalent temperature controlled furnace and occupies a very much smaller floor space, being, exclusive of tooling, approximately 6 feet by 6 feet.

Brazes are performed at high speed, most of them taking less than one minute. In many cases, multiple units can be brazed simultaneously. Selected heating of the part can be accomplished if the Thermoductor blocks can be designed to contact only the portion to be brazed. This, of course, is not possible for furnace brazing. The joints in most cases are made under slight pressure. For example, in a flat lapped joint, the two blocks braze the two pieces of metal under pressure, and therefore thin out the alloy giving a stronger joint than one in which there is a considerable thickness of alloy.

The unit is simple in operation and can use unskilled labor to produce highly complicated joints. The operating cost is considerably less than the equivalent furnace, since the area from which heat losses can occur is low and, in many cases, only a part of the work is heated instead of the whole.

One important facet of this type of unit is that it can be placed in a production line operation as a complete entity. It does not require an elaborate furnace layout.

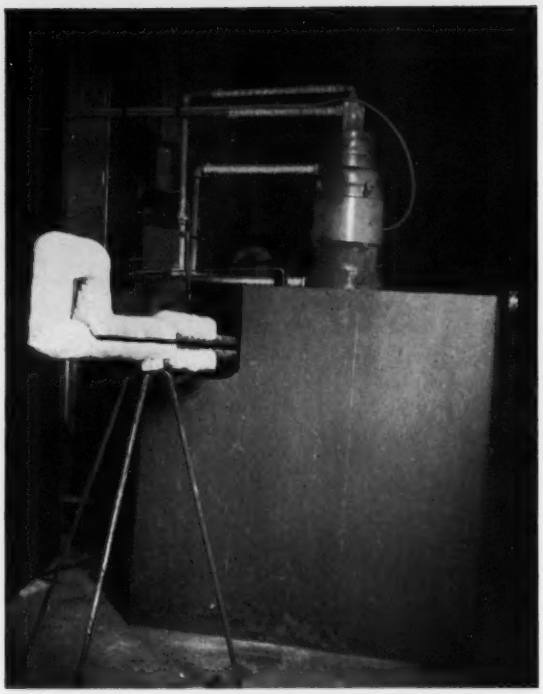
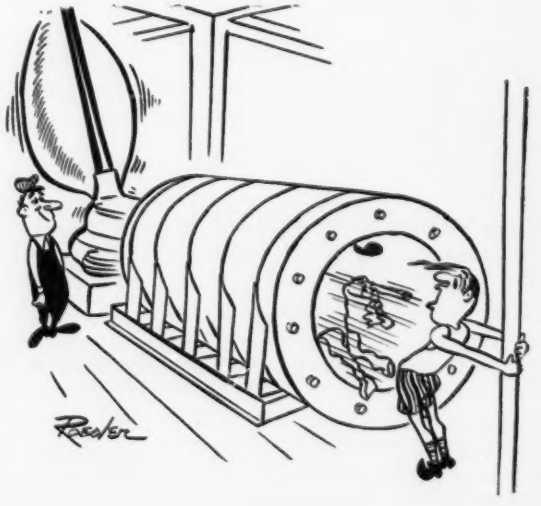


FIG. 4. Experimental 25 Kw pumped liquid brazing setup.

Compared to torch brazing, the number of rejects is reduced immeasurably since there is no possibility of any over-temperature which can damage the parent metal. Any of the aluminum and magnesium alloys, which can be brazed by conventional means, can be brazed as well or better by this new method using conventional alloys and fluxes. • • •



"Well, it's not my idea of a vacuum furnace!"

HEAT-TREATING HINTS

K. R. WILSON
Cuyahoga Products Corp.
Cleveland, Ohio

Quenching Fabricated Springs, Clips, Etc.

Heat treating is the most critical production operation involved in making the thousands of different springs, clips and fasterners that Cuyahoga Products Corporation, Cleveland, fabricates for its many customers.

Probably the most critical part of this operation is the quenching of parts as they come from the furnace.

Despite the many sizes, shapes, and purposes of the parts manufactured to supply a varied list of customers, all parts have one thing in common. They are small. It takes only about 10 lb. of steel, usually AISI 1060 or 1070, to make 1,000 parts. Stock thickness ranges from .015 to .035 in.

Without the right type of quenching oil properly used, the parts might not meet the specifications established by customers. Uniform hardness and freedom from cracks are essential.

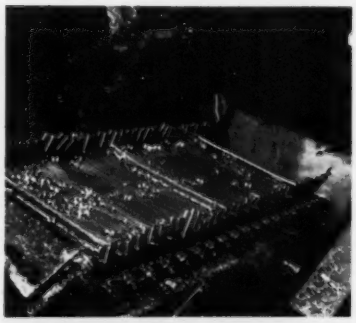


FIG. 1. Shown here is a typical batch of spring clips emerging from the quench tank at the discharge end of the furnace.

After considerable experimentation the company began using Gulf Super Quench. For the steels used and the type of parts treated, this oil has helped achieve deeper, more uniform hardening. It has a high initial quenching speed and apparently produces less distortion in high hardenability steels of varied sections and shapes.

FIG. 2. The most critical production problem in making tiny spring clips like these is to give them the proper, customer-specified hardness without developing hairline cracks in the sharp bends. Proper quenching procedure, using Gulf Super-Quench, has resulted in uniform production, fewer rejects.

The heat treating line consists of two controlled atmosphere American Gas Furnaces, two Lindberg gas-fired drawing furnaces, and wash tanks. The small parts are fed continuously into the shaker-hearth furnaces. Most of the parts are introduced into the first zone, which is held at 1,475 F. The middle and end zones of the furnaces are maintained at 1,500 F. Quenching oil is not pre-heated because parts supply sufficient heat to keep the oil at the desired temperature of 125 F. Circulating the oil from an external storage tank provides sufficient agitation in the quench tank.

In this continuous process parts are subjected to a heating cycle of 5 to 10 minutes before being dropped into the quenching oil, from which they are continuously removed by a steel mesh endless belt. After quenching, the parts are washed and then drawn to the hardness specified. Drawing is usually done from 650 F. to 750 F. Rockwell hardness of 58-60 is secured regularly.

• • •

About People.....

Alloy Sales Manager

L. John Harwood has been appointed sales manager by Alloy Steel Casting Company, Southampton, Pennsylvania. Mr. Harwood's previous foundry experience has been with Electro-Alloys, a division

L. John Harwood

of American Brake Shoe Company, and the Midvale Company.

He attended Rutgers and Penn State Universities and is a member of the American Society for Abrasives.

Thermo Electric Branch

Thermo Electric Company, Inc., Saddle Brook, New Jersey, manufacturers and designers of temperature measuring systems, thermocouples and accessories has opened a new factory office to service Southern California.

The new Thermo Electric office, located at 19458 Ventura Blvd., Tarzana, California, will be managed by Joseph J. Ghiglia, formerly with the Saddle Brook home office.

New ASM Manager

Appointment of T. C. DuMond as Manager, National and Regional Metal Congresses, American Society for Metals, has been announced by Allan Ray Putnam, managing director of the Society.

DuMond has also been appointed director, membership and chapter relations, confirming a responsibility he has held for a number of months. He will provide liaison, counsel and direction from ASM headquarters to the Society's 31,500 members in 112 Chapters throughout the United States and Canada.

In his Metal Congress function, he will work with national ASM committees in selecting subjects and titles for papers, panels and symposia, and in obtaining authors, speakers and session chairmen. He will also work with members of others societies including the Metal Treating Institute, to coordinate their technical programs with the ASM Metal Congresses.

T. C. DuMond

As editor of *ASM Transactions*, the annual record of scientific papers presented at the Metal Congresses, DuMond works with the national ASM Transactions Committee in publishing outstanding papers. He is also editor of *Metals Review*, the news-digest monthly for ASM members.

Changes at Heathbath

Kenneth J. Cave has been appointed technical sales representative for Heathbath Corp. His territory will cover Southern Ohio and West Virginia.

Ken is a graduate of Notre Dame University and was formerly associated with Oakite Products. In his new capacity he will handle sales of the firm's complete line of metal finishing and heat treating products. Ken's headquarters will be Columbus, Ohio.

Heathbath has also announced the promotion of Pete Petroff to the home office, Springfield, Massachusetts. Petroff has assumed duties as eastern district sales supervisor.

Information Director

A reorganization of public relations functions and the creation of two new divisions, information services and community services, has been announced by Joel Hunter, President, Crucible Steel Company of America.

Michael Stumm, manager of advertising and promotion for Crucible since 1948, has been appointed director of information services. Leo J. Murphy, formerly manager of public relations, has been named manager of community services.

Before joining Crucible, Stumm was director of public service for the

Michael Stumm

Miami Daily News and Station WIOD in Miami, Florida.

In addition to his present function, Stumm will be responsible for distribution of information to the press and public in the areas of commercial, production, technical and financial activities. His unit will serve as contact for the national press, radio and television in these areas.

Horak to Sales Post at Pacific Scientific

Richard F. Horak has been appointed manager of the new Pacific Scientific Company sales office at Denver, according to Charles H. Webber, executive vice-president.

The new sales-service office was opened to serve the rapidly growing aircraft, missile, and manufacturing industries in Colorado, Utah and Wyoming. The activity will cover a

Richard F. Horak

full line of aircraft and missile components, including items of flight safety accessories and electro-mechanical components, as well as heat treating furnaces and physical testing equipment.

Stanwood Corp Rep

The H. J. Gillis Company, Pompton Lakes, New Jersey has been appointed representative for northern New Jersey and metropolitan New York by the Stanwood Corp., Chicago to handle their line of baskets, trays, carburizing boxes, retorts, pots, special fixtures, and other heat treating equipment and parts for furnaces.

GE Promotions

Lewis G. Zirkle has been appointed manager of manufacturing for heat processing equipment by the General Electric Company's industrial heating department, Shelbyville, Indiana.

In his position, Zirkle will have responsibility for the manufacturing and assembling of all heat processing equipment and controls in the industrial heating plant.

James E. Wilson has been appointed manager of special heat processing for General Electric's industrial heating department at the firm's Shelbyville plant.

Wilson will succeed Richard A. Schaus, who has been named manager of fuel processing engineering for the company's atomic power equipment department at San Jose, California. Prior to his appointment at the Industrial Heating Department, Wilson was manager of advanced chamber materials engineering at General Electric's Rocket Engine Section, Evendale, Ohio.

Caterson Technical Editor

Michael Stumm, director of information services, announced that Alan G. Caterson has been appointed technical editor in Crucible Steel Company's newly created department. He was formerly supervisor of market development in the Titanium Division of the company's

Alan G. Caterson

Midland, Pennsylvania works. He also edited the *Crucible Titanium Review* and wrote many articles for publication.

He will be responsible for the distribution of information to the press and public in the areas of commercial, production, technical and financial activities, and will serve as contact for the national business and technical press, radio and television in these areas.

Furnace Division Manager

William C. Diman, long-time employee of C. I. Hayes, Inc., has been appointed manager of the furnace division of this Cranston, Rhode Island firm. Diman joined Hayes in 1946 after serving as Squadron Commander in the 9th Air Force in World War II.

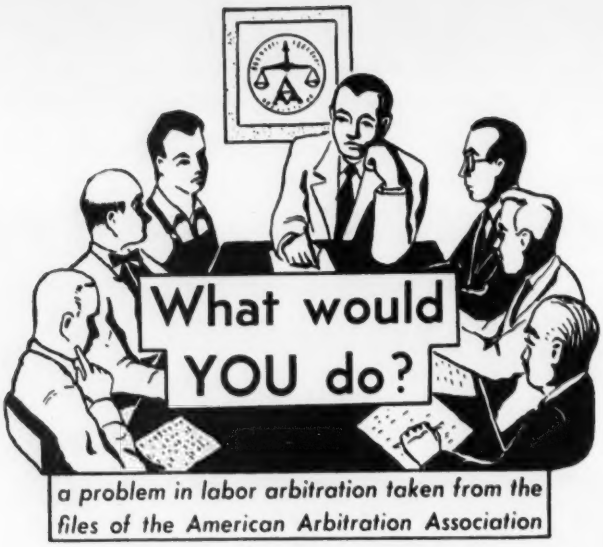
William C. Diman

In his capacities with Hayes as service engineer and furnace application engineer, he has originated many advanced furnace designs which have influenced heat treating techniques, particularly in the electronics and ceramics industries. In

Meet The Skipper

It's not all work and no play for industry members as is evidenced by this candid shot of John Paterson, a member of the board of trustees of MTI. John is shown tak-

ing a turn at the wheel of a schooner during a cruise between sessions of the Metal Treating Institute meetings held recently at the British Colonial Hotel, Nassau, Bahamas.



a problem in labor arbitration taken from the files of the American Arbitration Association

CASE OF THE TEMPORARY HELPERS

Although the contract between a union and a corn products refinery said that no new employees were to be hired while workers with seniority were on lay off, it had been the practice of management to hire college boys for temporary laboring work during the summer months, despite the fact that some female employees were on lay off from their packing room jobs. The personnel manager always cleared this procedure with the union president and the latter never objected because it didn't seem likely that the women could do the kind of work the boys were hired for.

But in the summer of 1959, things were different. The temporary hires were for some clean-up work and the union was sure the regular female employees would have qualified. So the union president refused to okay the deal and when the company hired some college boys anyway, a grievance was filed.

Eventually the matter went to arbitration under the rules of the American Arbitration Association. The union rested its case almost exclusively on the contract clause. The company admitted that the contract was clear on that point but insisted that the agreement was superseded by past practice. "All we're doing is what we've been doing every year for the past five," the personnel manager said. "The union can't object to it all of a sudden."

"We let it pass on a year-to-year basis. That's not the same as waiving our contractual rights forever," answered the international representative of the union.

What Would YOU Do?

THE AWARD: The arbitrator said: "A written agreement which is clear on its face can be modified only in writing. Past practice may properly be invoked to determine the intent of an unclear provision but it may not be invoked to vitiate the terms of an unambiguous provision, especially in circumstances where deviation from the agreement's tems occurred after specific notice to the union and without the union's consent." The union won the case and, since it was the arbitrator's opinion that the women could have performed the clean-up work, they were reimbursed.

NEWS TO HEAT TREATERS...

Heating Costs Cut 80%

By using a unique cellular silica material to insulate their new atmospheric brazing furnace, Pacific Scientific Company of Los Angeles, California, were able to save an amazing 80% of the estimated heating costs. And, since they were able to eliminate four-fifths of the usual firing equipment, production costs were cut by $80,000.

The furnace was designed for a large aircraft subcontractor to be used in the manufacture of honeycomb aircraft and missile parts. Honeycomb sections up to 12 ft. wide by 20 ft. long by 4 ft. in height can be handled in the furnace.

Key to the furnace's performance is a new, lightweight refractory, Foamsil, a product of the Pittsburgh Corning Corporation. The material is 99% pure fused silica glass foamed in a special, very high temperature furnace to create millions of tiny sealed cells. The material can cycle from -450 F. to +2,000 F. without thermal shocking. It weighs only 13 lbs. per cu. ft. yet has a compressive strength of 200 lbs. per sq. in.

Key factor is the material's low specific heat—only .277 at 1,200 F.—combined with light weight. According to Harold E. Mescher, Director of Research and Development at Pacific Scientific, "Foamsil requires five times less heat to bring a given load up to temperature."

He also states that the tremendous growth of the aircraft and electronics industries has brought with it complex problems in the design and manufacture of components to make them smaller and more heat resistant. This, in turn, has called for new concepts in furnace design—faster handling methods, automatic controls and consistently even heats. The art of brazing, itself, has become more complex by the day because the demand for these components has brought special stainless steels and rare alloys out of the research stage and into actual production.

The introduction of these metals has necessitated new brazing techniques and new furnace designs.

The problem is to make dependable brazed joints in these alloys on a production basis and with a minimum of rejects. To do this, a brazing furnace must provide accurately controlled heating and cooling cycles; in many cases, allow components to be handled in the protective atmosphere of a retort; and must provide facilities for fast loading and unloading.

FIG. 1. Artist's conception of completed furnace.

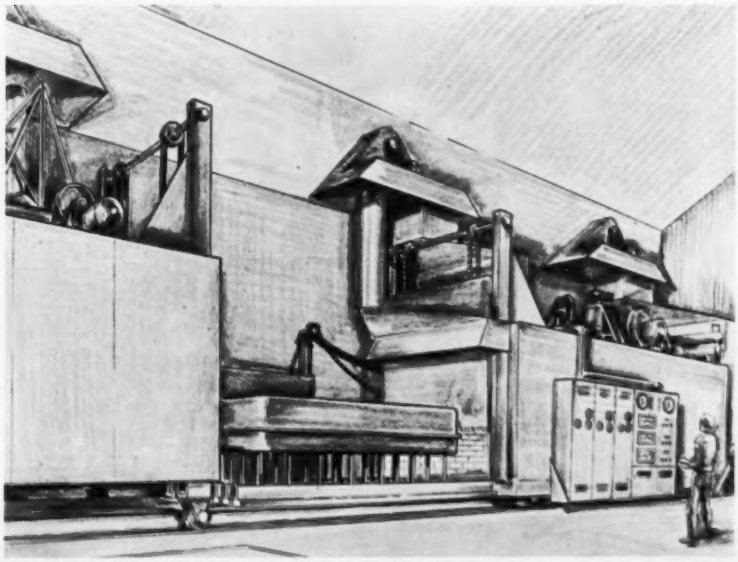


FIG. 2. Cutting Foamsil insulating refractory.

In designing the production brazing furnace, three honeycomb brazing problems had to be overcome: (1) the material had to be held very straight, (2) it must be heated to the desired temperature very rapidly, and (3) the heat must be taken out of it quickly to enable the braze to set.

The first problem was overcome by the design of a portable furnace which would move over the part to be brazed as it rests on upright rods and then backs away from it after the brazing operation.

Foamsil took care of the other two problems because of its low residual heat capacity, light weight and low heat storage capacity.

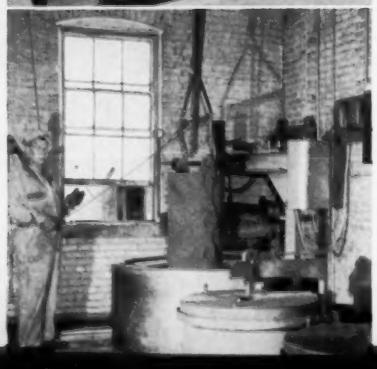
The furnace is designed to operate at a temperature of approximately 2,000 F. Over-all dimensions are 91 ft. by 21 ft. Forty-six gas burners supply the needed heat.

A total of 3,000 bd. ft. of Foamsil was installed in the furnace. A double row of 17 in. by 22 in.

Continued on page 30

TODAY THE TREND IS UP

Modern specifications call for better properties achieved by better heat treating —check with your commercial heat treater



Whenever a modern product is improved or a new one developed it has now reached a point where the heat treating procedures and processes to be applied to basic component parts are among the original factors to be considered. In the past, fabricating methods and metals were frequently the first to be specified and heat treating, if involved at all, was a secondary problem.

Because of this and because of the new and exceptional design characteristics and ultimate engineering properties which can be achieved only through skillful and accurate heat treating, the tonnage volume of heat treating materials processed by the commercial heat treating industry grows steadily month after month.

There is another reason for this and it is found in the fact that only the commercial heat treater offers practically an all inclusive diversity of plant facilities, but even more important, the accumulation of technical skills, experienced personnel, and the background of knowledge so essential to this field.

If you would like to receive a charted monthly report of the volume of activity in this industry, write us on your company letterhead. We will be glad to send it to you.

Whatever your heat treating problem, always check with your commercial heat treater first.

THERE'S A HEAT TREATING SPECIALIST NEAR YOUR PLANT

ALABAMA

Southern Metal Treating Co., Inc.
3131 10th Ave. N., Birmingham 4

CALIFORNIA

Downey Steel Treating Co., Inc.
9637 Nance St., Downey
National Heat Treating Co., Inc.
1833 W. Florence, Inglewood 1
Certified Steel Treating Co.
2454 E. 58th St., Los Angeles 58
Lindberg Steel Treating Co.
2910 S. Sunol Drive, Los Angeles 23
Cook Induction Heating Co.
4925 East Slauson Ave., Maywood

CONNECTICUT

Commercial Metal Treating, Inc.
89 Island Brook Ave., Bridgeport 6
Stanley P. Rockwell Co.
296 Homestead Ave., Hartford 12
Ireland Heat Treating Co.
512 Boston Post Road, Orange

ILLINOIS

Accurate Steel Treating Co.
2226 W. Hubbard St., Chicago 12
Allied Metal Treating Corp. of Illinois
333 N. California Ave., Chicago 12
Dura-Hard Steel Treating Co.
2112 W. Rice Street, Chicago 22
Perfection Tool & Metal Heat Treating Co.
1756 West Hubbard St., Chicago 22
Fred A. Snow Co.
1942 West Kinzie St., Chicago 22
American Steel Treating Co.
P. O. Box 396, Crystal Lake
Lindberg Steel Treating Co.
1975 N. Ruby St., Melrose Park
Eklund Metal Treating, Inc.
721 Beacon St., Rockford
Scott Ford, Inc.
2719 Fifth St., Rock Island
Ipsenlab of Rockford, Inc.
2125 Kishwaukee Street, Rockford
O. T. Muehlemeyer Heat Treating Co.
1500 Preston St., Rockford

INDIANA

Quality Steel Treating Company
1630 Locust Street, Anderson
Industrial Heat Treating & Metallurgical Co., Inc.
2131 Northwestern Ave., Indianapolis 2

MASSACHUSETTS

Kinetics Corporation
2 Churchill Road, Hingham
Porter Forge & Furnace, Inc.
74 Foley St., Somerville 43
New England Metallurgical Corp.
475 Dorchester Ave., South Boston 27
Springfield Heat Treating Corp.
99 Margaret Street, Springfield
Greenman Steel Treating Co.
284 Grove St., Worcester 5

MICHIGAN

Anderson Steel Treating Co.
1033 Mt. Elliot Avenue, Detroit 7
Bosworth Steel Treating Co.
18174 West Chicago Blvd., Detroit 28
Commercial Steel Treating Corp.
6100 Tireman Ave., Detroit 4
Commonwealth Industries, Inc.
5922 Commonwealth Ave., Detroit 8
Vincent Steel Process
2424 Bellevue Ave., Detroit 7
State Heat Treat, Inc.
520 32nd Street, S. E., Grand Rapids 8
Royal Oak Heat Treat, Inc.
21419 Dequindre, Hazel Park
American Metal Processing Co.
12000 East Nine Mile Road, Warren

MISSOURI

Lindberg Steel Treating Co.
650 East Taylor Ave., St. Louis 15
Paulo Products Co.
5711 West Park Ave., St. Louis 10

NEW JERSEY

American Metal Treatment Co.
Spring and Lafayette Sts., Elizabeth
Benedict-Miller, Inc.
Marin Ave. & Orient Way, Lyndhurst
Bennett Heat Treating Co., Inc.
246 Raymond Boulevard, Newark 5
L-R Metal Treating Corp.
107 Vesey St., Newark 5
Temperature Processing Co., Inc.
228 River Road, North Arlington

NEW YORK

Owego Heat Treat, Inc.
Rural Route 1, Apalachin
Eastern Heat Treating & Brazing Corp.
44 Sea Cliff Avenue, Glen Cove
Fred Heinzelman & Sons, Inc.
138 Spring St., New York 12
Alfred Heller Heat Treating Co., Inc.
391 Pearl St., New York 38
Lindberg Steel Treating Co.
620 Buffalo Road, Rochester 11
Rochester Steel Treating Works
962 Main Street, E. Rochester 5
General Heat Treating Corporation
206 Sand Street, Syracuse 3
Syracuse Heat Treating Corp.
1223 Burnet Ave., Syracuse 3

OHIO

Queen City Steel Treating Co.
2980 Spring Grove Ave., Cincinnati 11
Ferrotherm Co.
1861 E. 65th St., Cleveland 3
Lakeside Steel Improvement Co.
5418 Lakeside Ave., Cleveland 14
The Modern Steel Treating Co.
5466 Lake Court, Cleveland 14
George H. Porter Steel Treating Co.
1273 East 55th Street, Cleveland 3

OHIO — (Cont'd)

Reliable Metallurgical Service, Inc.
3827 Lakeside Ave., Cleveland 14
Winton Heat Treating Co.
20003 Lake Road, Cleveland 16
Dayton Forging & Heat Treating Co.
2323 East First St., Dayton 3
Ohio Heat Treating Co.
1100 East Third St., Dayton 2

PENNSYLVANIA

Drever Company
Red Lion Rd. & Philmont Ave., Bethayres
Robert Wooler
Dresher
Wiedemann Machine Co.
Gulph Road, King of Prussia
J. W. Rex Co.
Eighth and Franconia Avenue, Lansdale
Lorenz & Son
1351 N. Front St., Philadelphia 22
Metlab Company
1000 E. Mermaid Lane, Philadelphia 18
Pittsburgh Commercial Heat Treating Co.
49th St., and A.V.R.R., Pittsburgh 1
Pittsburgh Metal Processing Co., Inc.
1850 Chapman Street, Pittsburgh 15

TEXAS

Dominy Heat Treating Corp.
P. O. Box 5054, Dallas
Superior Heat Treating Co., Inc.
P. O. Box 69, Fort Worth 1
United Heat Treating Company
2005 Montgomery Street, Fort Worth 7
Cook Heat Treating Co., of Texas
6233 Navigation Boulevard, Houston 11
Houston Heat Treating Company, Inc.
2100 Quitman Street, Houston 26
Lone Star Heat Treating Corp.
5212 Clinton Dr., Houston 20

WISCONSIN

Allied Metal Treating Corp.
P. O. Box 612, Milwaukee 1
Heat Treating Engineers, Inc.
1146 North 54th St., Milwaukee 8
Metal Treating, Inc.
720 South 16th St., Milwaukee 4
Supreme Metal Treating Co.
4440 West Mitchell St., Milwaukee 14
Thurner Heat Treating Co.
809 West National Ave., Milwaukee 4
Wisconsin Steel Treating & Blasting Co.
1114 South 41st Street, Milwaukee 15
Harris Metals Treating Co.
4100 Douglas Ave., Racine

CANADA

Ipsenlab of Canada Limited
27 Bermondsey Road, Toronto 16, Ont.

For further information circle No. 8

All of the above listed firms are members of the

METAL TREATING INSTITUTE

271 North Avenue, New Rochelle, N. Y.

Continued from page 27

blocks were installed; one layer of 2 in. thick and another of 3 in. thick. Special Foamsil cement was used as the adhesive. A 4 in. layer of another insulating material was used as back-up.

Total weight of the furnace is 75,000 lbs. The hearth alone weighs 25,000 lbs. Total cost is $163,000. Of this figure, $20,000 is for heating equipment. Had Foamsil not been used, heating equipment alone would have cost $100,000.

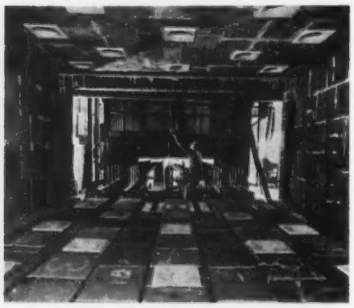


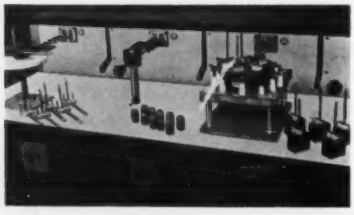
FIG. 3. Interior of heating chamber with heating forks installed.

Apart from fuel and equipment savings, the large, but light, cellular silica blocks enabled speedier installation with accompanying savings in labor costs.

For further information circle No. 9

All-Purpose Table

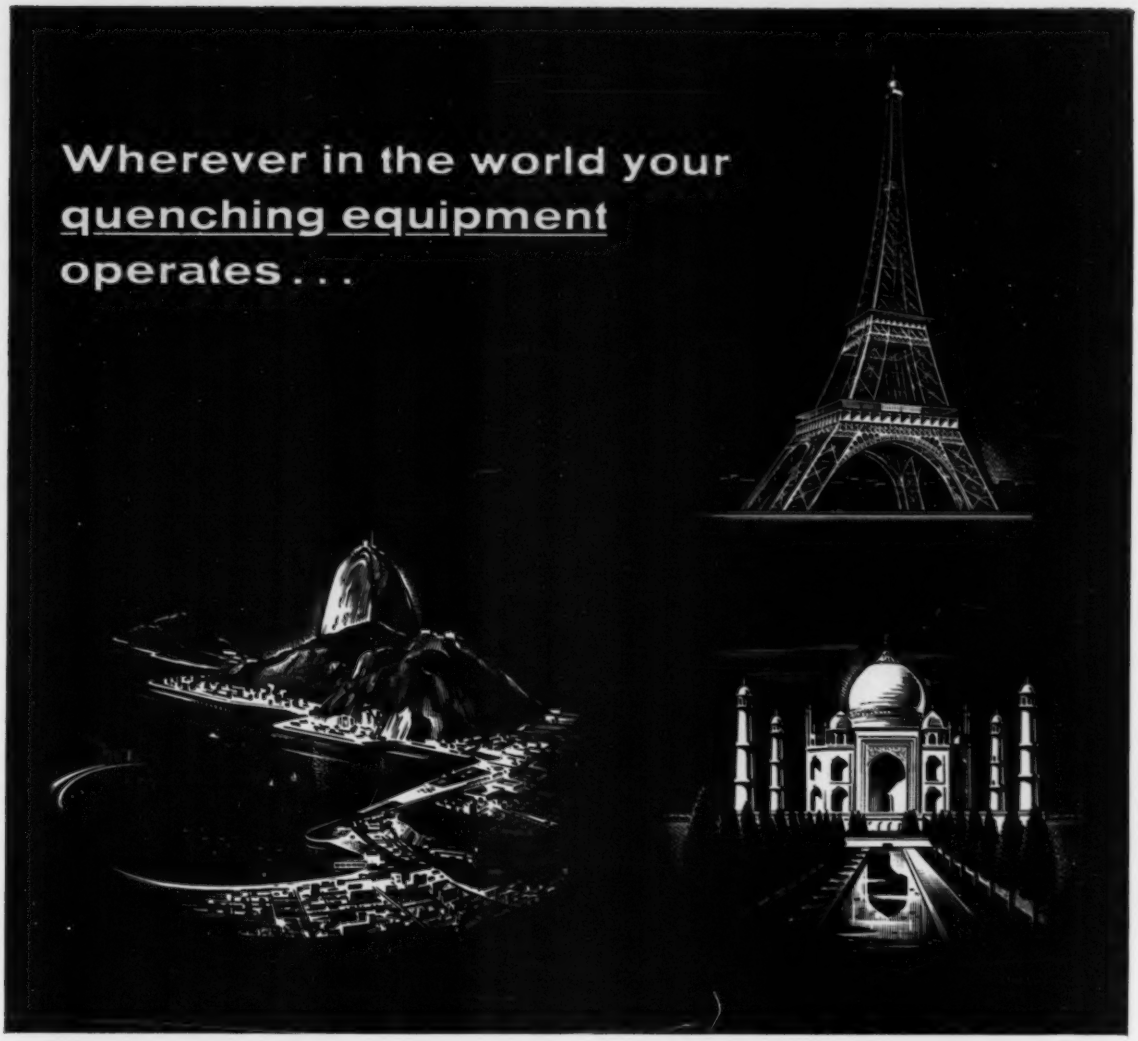
Lepel High Frequency Laboratories, Inc., Woodside, New York, has developed a line of multiple position work tables with built-in power transfer switches for numerous induction heating applications such as soldering, brazing, bombarding and heat treating.



In the illustration, the set-up on the left shows a five piece assembly being soldered in one open end coil using pre-formed solder rings; in the center of the table, tungsten contacts are being brazed to brass bodies using silver solder; and on the right, five copper and brass assemblies are being soldered within one heating coil. The three-position work table is powered by a single induction heating generator, which can be switched from one working station to another.

Outstanding feature of the table is the advantage of leaving the operating set-up as is — proceeding to the next application, then returning to the original set-up without loss of time. The work table is equipped with pilot lights to indicate the station being powered. Each station can be operated by a push-button, footswitch or timer. These work tables can also be built with quench tanks for heat treating applications.

For further information circle No. 10



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Shell Turbo Oils—for utility, industrial and marine turbines

Shell Rimula Oils—for heavy-duty diesel engines

Shell Talona R Oil 40—anti-wear crankcase oil for diesel locomotives

Shell Dromus Oils—soluble cutting oils for high-production metalworking

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AN INTERESTING FACT!

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Shell Voluta Oil is there

Around the world, Shell Voluta Oil is available—under the same brand name and providing the same outstanding quenching oil effectiveness. This is assurance that your customers abroad will enjoy the same performance from your heat-treating equipment that domestic customers rely upon.

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SHELL

For further information circle No. 12

$200 Million In Leases

Equipment leased by metalworking firms will soar to more than $200 million by the end of 1960, the Metal Treating Institute convention was told in Nassau during their spring convention.

Gordon H. Wolfe, of New York, eastern vice president for Nationwide Leasing Company, Chicago, said that more equipment was leased by metalworking firms than any other industry group. At the end of 1959, he added, there was approximately $118 million worth of equipment on long-term lease to metalworking companies.

Wolfe also pointed out that long-term equipment leasing is proving to be a major aid to manufacturers of industrial machinery in the metalworking field. He predicted that approximately $50 million worth of equipment manufactured by metalworking companies would be leased in 1960. This increase, about 42 per cent over 1959, he attributed to the introduction of lease plans by a number of equipment manufacturers, such as Verson Allsteel Press Company, Chicago.

Water Saver Deluxe

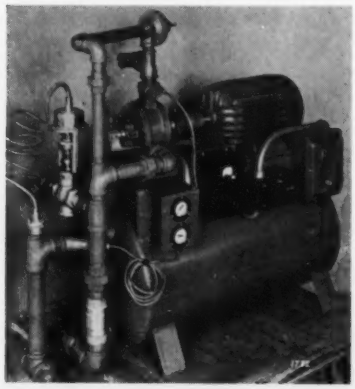
A self-contained water recirculating system, which saves upwards of 50% in water consumption, has been designed for use with all induction heating equipment. The unit also contains a special electromagnetic device to control formation of scale and corrosion.

The Ther-Monic Water Economizer was designed and built by the Induction Heating Corporation of Brooklyn, New York.

An electro-magnetic device on the supply end charges the solids of the water and prevents them from clinging to the storage tank or the inside of the plumbing. They simply pass through the system and out the drain, which prevents the formation of scale.

Temperature of the water may be controlled at any setting in the range from 75 F. to 150 F. by a finger operated dial on the auto-

matic thermostatic valve on the inlet water line. A dial type thermometer indicates the temperature of the circulating water. The amount of water that can be saved depends upon water supply temperature and the maximum allowable temperature of cooled equipment.



Pressure in the system is automatically fixed by an adjustable pressure regulator on the output side of the pump. A dial gauge monitors pressure visually. Drive for the pump is supplied by a totally enclosed, continuous duty motor of 1½ HP, 220/440 volts.

The system is complete with overload protection, manual motor starter and control transformer.

For further information circle No. 14

New Indicating Labels

A simple method for temperature detection and indication through 1,100 F. is now available in the form of Temp-Plates, adhesive-backed temperature indicating labels, manufactured by Pyrodyne, Inc., Los Angeles, California.

The increments, calibrated to an accuracy of plus or minus 1 per cent, change from pastel to jet-black to give a positive, irreversible record of heat exposure. From 500 F. to 1,100 F. in fifty degree steps, the indicators are ceramically isolated on stainless steel foil plates; from 100 F. to 500 F., the plates are offered in plastic casing. Highly flexible and immune to most ambient conditions, Temp-Plates will adhere until intentionally removed.

Designed for detection of hazardous excess temperatures, Temp-Plates provide a safeguard for equipment and personnel by pointing up over-heat conditions on brakes, engines, exhaust manifolds, rocket engine housings, heat exchangers, nose cones and other critical areas.

For further information circle No. 15

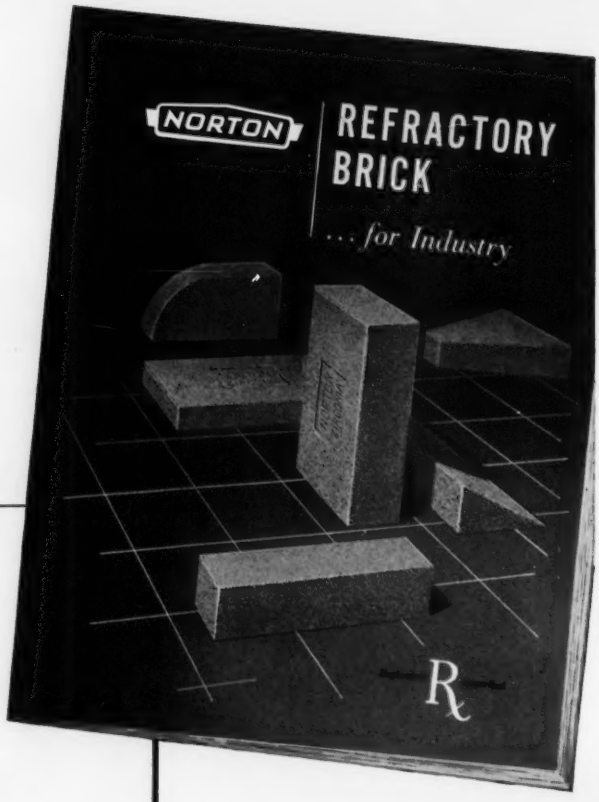
"Specialty Steels"

Pittsburgh executives of the Crucible Steel Company of America recently entertained members of the local Pittsburgh area press, radio and TV and editors and publishers

Continued on page 35

Send for this

New Booklet to Help Improve Your High Temperature Processing



Covers Norton refractory brick applications, characteristics, chemical analyses — includes helpful data on materials of construction for temperatures up to 4,400°F.

This new, 24-page Norton booklet can be a dependable guidebook for your selection of the refractories you need to improve production and cut costs in high temperature processing.

Eight Norton-developed refractory materials are covered: ALUNDUM* "T" 87% Alumina; ALUNDUM "A" 99% Alumina; ALUNDUM "L" 99% Insulating Alumina; CRYSTOLON* "G" Silicon Carbide; CRYSTOLON "N" Nitride Bonded Silicon Carbide; MAGNORITE* "K" Fused Magnesia; Zirconia "H" Dense Zirconia; Zirconia "I" Insulating Zirconia.

All essential details are listed, such as: how each material is produced . . . important properties, characteristics and chemical analyses . . . shapes of brick and other molded products that are available . . . representative applications . . . packing methods that assure safe arrival.

Also included are charts and tables of brick shapes and sizes, thermal expansion and conductivity graphs, and a temperature conversion chart.

Norton refractories — engineered and prescribed for the widest range of applications — have helped many users save time and money. The Rx's described in "*Norton Refractory Brick . . . for Industry*" may do the same for you. Write for your copy to NORTON COMPANY, Refractories Division, 624 New Bond Street, Worcester 6, Massachusetts.

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Engineered... Rx ...Prescribed
Making better products . . . to make your products better

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

NORTON PRODUCTS Abrasives • Grinding Wheels • Grinding Machines • Refractories • Electrochemicals — **BEAR-MANNING DIVISION** Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

For further information circle No. 17

NEWS TO HEAT TREATERS

Continued from page 33

of the National Technical and Business press for a showing of Crucible's new 45 minute color film "Specialty Steels."

The film was planned by Michael Stumm, director of information services, to tell the story of the science and the art which goes into producing the special purpose steels, such as stainless steels and tough wear and shock resistant steels for the tool room. It was produced by the Marshall Organization, Inc., New York.

The music, which accompanies the story of specialty steels, is a special performance of the Zurich, Switzerland, Symphony Orchestra, and has not been played before in this country.

For further information circle No. 18

Poly-Rustex

A universal rust inhibitor compound that gives long lasting corrosion protection to new metals, fabricated parts, machinery and tools, and all other forms of iron and steel with a single easy, low-cost application has been developed and is now being marketed by Brad Chemical, Inc., Chicago.

Called Poly-Rustex, the new preparation is a special combination of active materials dispersed in an oil carrier base. The exclusive ingredients penetrate deeply through existing corrosion to the bare metal and form a solid air-and-moisture-tight seal, thus preventing formation of new rust. The only clear rust inhibitor on the market, Poly-Rustex will not discolor the metal, yet provides complete protection that will not wash or wear away under normal conditions.

Poly-Rustex comes ready to use without mixing, and can be easily and quickly applied to any metal surface by a variety of methods: brush, spray, mop or dip.

For further information circle No. 19

Portable Temperature Chamber

A precision temperature test chamber capable of accomodating rack-mounted electronic equipment has been announced by Delta Design, Inc. Prolonged temperature runs with stability to within ½ F. over the range -100 F. to +500 F. can be economically made.

The new chamber provides one of the most accurate temperature controls as well as the highest ratio of test volume to overall volume of any portable temperature chamber presently available to the electronics industry.

Described as Model 7000A of Delta Design's Precision Series of test units, the chamber has an internal test volume of 19½ by 11 by 15 in., easily handling the 19 in. standard rack unit. Model 7000A attains its high degree of temperature stability through the use of a thermocouple and a precision meter-relay.

With an auxiliary timer-control unit, Model 7000A can be pre-set for automatic hot-cold cycling at

Continued on page 37

Fig. 1. Cincinnati 30kw Inductron heating machine now in operation at Dearborn Gear and Tool Company, Detroit, Michigan.

70 more than specified!

Required by Dearborn Gear & Tool Co., Detroit: a method for rapid hardening 3½" of the bearing surface and spline of automobile starter armature shafts (part shown above). Minimum hardness, 40 Rc; .010" - .030" depth; 460 parts per hour, minimum rate.

The economical solution: A 30kw Cincinnati Inductron heating machine, plus ingenious tooling developed by Cincinnati's Heat Engineers. The photos below show the tooling that maintains a constantly uniform specified hardness pattern throughout a production rate of 530 parts per hour. And that is 70 more parts per hour than the minimum rate required.

530 ARMATURE SHAFTS PER HOUR HARDENED BY A CINCINNATI INDUCTRON AT DEARBORN GEAR & TOOL COMPANY

Cincinnati builds *both* Flamatic® flame heating, and Inductron® induction heating machines. For detailed information on how you can obtain top efficiency and economy for your heat processing work, call in a Meta-Dynamics Division field engineer. Backed by the resources of Cincinnati's completely equipped and staffed heat engineering laboratories, your needs will be thoroughly analyzed, your parts "test run," and specific, unbiased recommendations made.

Fig. 2. Shafts are received in hopper and positioned so that a horizontal, multiple-speed cam feeds the parts through the coil. Cam has OD contoured to provide the proper feed rate for the different diameters of the part. When the required 3½" length is heated, limit switch cuts off current as the remainder of the shaft is rapidly passed through coil. Heat cycle is again energized as next shaft enters coil.

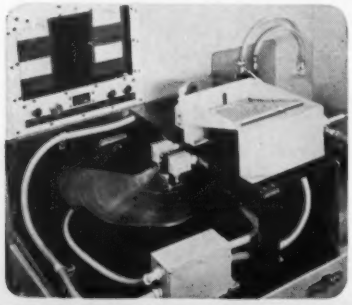
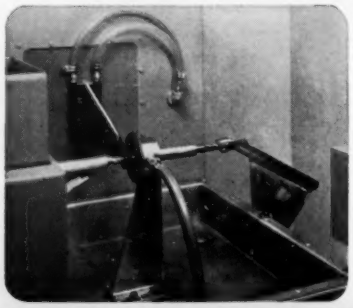


Fig. 3. Close-up view of heat-quench area showing one shaft entering discharge chute while another shaft is passing through coil. Quench head is positioned adjacent to the coil and applies spray quench to the areas of the part that have just been heated. Three shafts are always in line, and parts are continuously fed through the coil, one shaft pushing another.



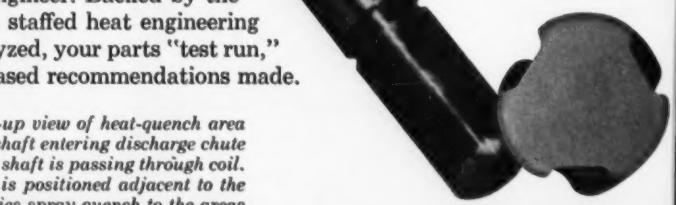


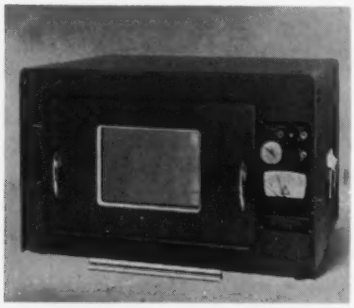
Fig. 4. Cross section of splined area of armature shaft, showing uniform pattern of .020" minimum case depth. Minimum hardness achieved is 40 Rc.

inductron
flamatic
hardening machines
META-DYNAMICS DIVISION
Machines for Metal Forming and Heat Treating
THE CINCINNATI MILLING MACHINE CO.
Cincinnati 9, Ohio, U.S.A.
CINCINNATI

NEWS TO HEAT TREATERS

Continued from page 35

alternate temperature levels throughout the chamber's -100 to 500 F. range. The auxiliary timer is availa-



ble as optional equipment. The chamber control is not subject to drift due to line voltage variations even on prolonged runs.

The aluminum cabinet of the Model 7000A is finished in gray wrinkle enamel. The interior is of stainless steel. Readily available liquid CO_2 is used for cooling. The chamber is supplied with a Pyrex window for convenient visual observation, and a large access port accomodates all feed-through connections.

For further information circle No. 22

Miniature Grinding Wheels

A new line of miniature precision mounted grinding wheels, known as "Minigrind" mounted wheels has been developed and is commercially available from Norton Company.

These abrasive wheels, made as small as .036 in. diameter and as thin as .016 in. were developed for use in miniature precision bearing manufacture. Additional applications are being found in the tool and die industry, specifically on jig grinders.

New mounting methods had to be devised to fasten the fired abrasive section to the needle thin stainless steel precision mandrels. Unlike most conventional mounted wheels, Minigrind wheels require the mandrel's mounting end to extend

Continued on page 38

Continued from page 37

through and support the entire length of the abrasive section.

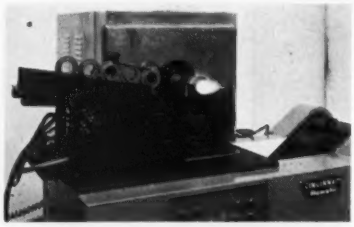
Because of the extremely small diameters, these wheels must rotate at extremely high speeds to insure proper grinding action. Even at 100,000 to 150,000 revolutions per minute of the ultra high speed spindles on the machines using these wheels, the surface feet per minute of the wheel sometimes gets as low as 1000. Normal grinding speed for conventional grinding is about 6,500 s.f.p.m.

For further information circle No. 25

Special Tooling Process

Pictured here is a close-up of a new Cincinnati Flamatic equipped with a water cooled rotating flame head. The automatic stator hub, with dimensions of 3.94 in. O.D. and 2.157 in. I.D., is made of SAE 1062 steel and has the inside bore hardened to 60-62 RC with a depth hardness of .125 in. Production capacity is rated at 208 parts per 52 min. hour.

Sequence of the process begins with the part being fed by gravity down an inclined chute, then located on a cradle type fixture in front of



the rotary flame head. The flame head then advances into the part bore and rotates as it selectively heats the I.D. At completion of the heating cycle, the flame head retracts, the cradle tips forward and the part is dropped into an integral quench tank. A conveyor then carries the part out of the quench tank.

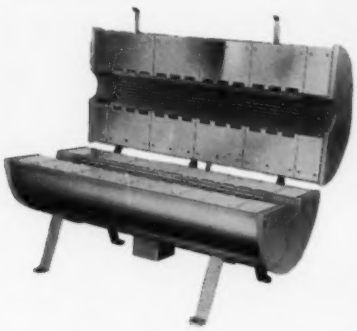
For further information circle No. 26

Combustion Furnaces

Hevi-Duty Electric Company a division of Basic Products Corporation has announced a complete new line of combustion tube furnaces capable of operating at temperatures of 2,200 F. These furnaces constitute an extension of the 1,850 F. Combustion Tube Furnace line manufactured by Hevi-Duty Electric Company.

The furnaces built for 2,200 F. operation feature vestibules on each end of the heating chamber to reduce heat losses and effectively extend the length of the uniform hot zone. Heat source is a helical coil, high temperature alloy heating element mounted in semi-cylindrical

refractories of the multiple unit design. These heating units can be arranged for multiple zone temperature control to provide optimum temperature uniformity over an extended length.



Hevi-Duty Combustion Tube Furnaces, capable of operating at temperatures to 1,850 F. are now available in an expanded variety of sizes. Many sizes are available from stock for immediate delivery. Furnaces may be used in either a vertical or horizontal position and have become a standard for use in creep and tensile testing equipment.

Furnaces in both temperature ranges are available in either the solid or hinged construction. They are also available with or without indicating or controller pyrometers.

For further information circle No. 28

Magnaflux Containers

A new development being marketed by Magnaflux Corporation is the convenience of magnetic particle inspection materials available in pressurized spray cans and plastic squeeze-bottles. These materials can be used with any of the magnetic particle inspection equipment or test kits already in operation throughout industry.

This innovation has been fully tested in Magnaflux Research Laboratories and commercial inspection plants. It proved to be a major advance over earlier Magnaflux test materials by making tests faster and easier, when used in field testing and on parts of complex shape being

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For further information circle No. 29

NEWS TO HEAT TREATERS

Continued from page 39

tested on large wet-type Magnaflux units.

The ready to use Magnaflux-Magnaglo materials eliminate previous bulky containers, and the problems of mixing to formula, or filling application devices, and reduce set-up time to inspect complex parts. The new sealed dispensers keep out dust, moisture, and other contamination during storage.

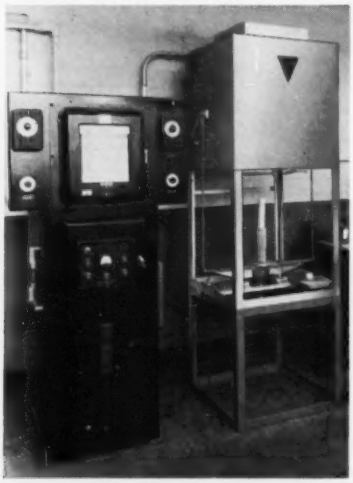
Pictured here is the Magnaflux gray powder in a plastic squeeze-bulb. The material, in this case, is being used to test a premagnetized part for cracks.

For further information circle No. 31

Vertical Tube Furnace With Kanthal Elements

A new vertical tube furnace, incorporating Kanthal super heating elements, and designed for an operating temperature range to 1,600 C. has been announced by the Pereny Equipment Company, Inc., Chambers Road, Columbus, Ohio.

Known as the Model MTKS-312, this new unit incorporates a 3 in. I.D. by 30 in. impervious mullite tube with the Kanthal super heating elements mounted vertically and parallel to its main axis. The hot zone is 12 in. long. A vertical-lift loading column is counterbalanced for manual operation.



The heavy-duty all welded steel case is insulated with 9½ in. graded, super-duty, lightweight insulating refractory. Overall size is 30 in. wide by 30 in. deep by 60 in. high.

Complete reactor "package", strip chart indicator-controller-recorder and required platinum thermocouple, as well as internally wired controls are all mounted in a separate matching floor-type steel panel.

For further information circle No. 33

Work Glove Automat

Arlington Industries, Revere, Massachusetts, has issued a catalog describing its Work Glove Automat which is designed to make work

Continued on page 42

NEWS TO HEAT TREATERS

Continued from page 41

gloves readily available to employees but under close administrative control.

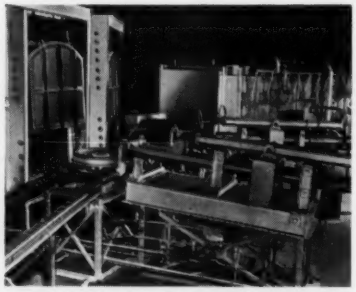
The Automat consists of a wall hung steel cabinet operating on special alloy tokens to dispense any type of work glove. It is adaptable to any existing glove program—free

issue or sale at cost. Features include a sensitive slug rejector and non reset counter. In combination these function honestly, 24 hours a day, as automatic clerk, auditor and glove depot.

For further information circle No. 36

25% Griffin Increase

Griffin Wheel Company increased production of railroad car wheels 25% with the recent installation of a specially designed Lindberg Preheat Furnace.



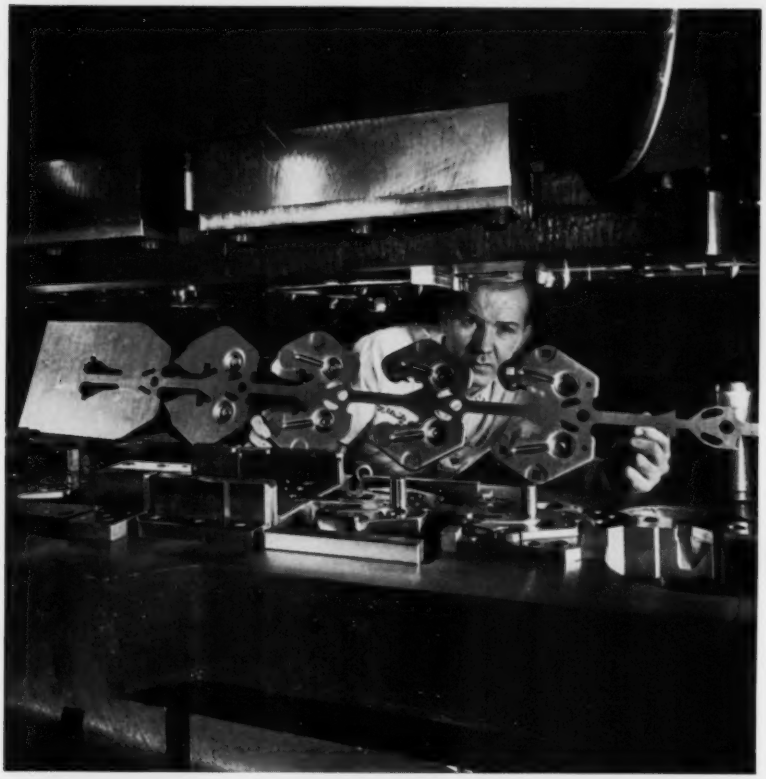
The automated installation speeds up the heat treating operation. In the process, car wheels are automatically conveyed into the preheat furnace, brought quickly to the desired temperature and automatically conveyed into the Lindberg Rotary Hearth Furnace, previously installed at the Colton Plant.

For further information circle No. 37

Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation



Another report on Lehigh H tool steel—
"good machinability . . . very low distortion"

7-STAGE DIE FORMS AUTOMOTIVE DECK HINGE PART

This 7-position progressive die of Bethlehem Lehigh H tool steel was made recently by Hillside Tool & Die Company, Roseville, Michigan, for the production of an automotive deck hinge part, from 13-gage sheet steel. The die, made from Lehigh H supplied by our local distributor, Peninsular Steel Co., Detroit, was hardened to Rockwell C 60. It was used in a 400-ton press.

When asked about the performance of the tool steel, a Hillside engineer reported, "We like Lehigh H in jobs of this type because of its good machinability, and its very low distortion during heat-treatment. The die was placed in service with hardly any stoning necessary."

Bethlehem Lehigh H (AISI D-2) is our easy-machining, high-carbon, high-chrome grade of air-hardening tool steel. It has outstanding wear-resistance, due to its excellent carbide distribution.

Your Bethlehem tool steel distributor can give you full details on Lehigh H . . . and he has many sizes in stock.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Here's how to shrink-fit tool inserts

Shrink-fitting of tool steel inserts, commonly used in improving the service life of tools, is most applicable to rings and cylinders used in heading and drawing operations, where the tools can be shrink-fitted into large retaining rings. The shrink-fit sets up radial compressive stress in the tool. This serves to oppose radial tensile stress set up in service, thereby improving the performance over solid tools which are not pre-stressed.

Here's how to do it:

1. The retainer should have adequate diameter and strength to provide the stresses required on the tool insert. Generally, an alloy steel capable of hardening to 300-400 BHN is used. Shock-resisting tool steels, heat-treated to Rockwell C 48-52, are recommended for heavy-duty applications. The OD of the retainer should be at least twice, and preferably three times, the ID.

2. Allow for a shrink-fit of .003/.004 in. per in. Thus the OD of the insert is .003/.004 in. per in. larger than the ID of the retainer into which it is to fit. These dimensions must be maintained to obtain the benefits of shrink-fitting.

3. It is important that the OD of the insert and the ID of the retainer have a smooth finish, preferably produced by grinding.

4. Heat the retainer to a temperature sufficient to cause the expansion required in assembling the insert. Do not exceed the tempering temperature used in heat-treating the retainer. If necessary, the insert may be sub-zero cooled, to help provide the proper clearance for assembly.

5. After assembly of the parts, the assembly should be cooled rapidly. This will prevent over-tempering of the insert by heat transferred from the retainer.

ISOTHERMAL HEAT TREATMENT

Concluded from page 15

above the upper critical. If the forging is such that cold areas are obtained, *i.e.*, some portion of the forging being below the upper critical temperature-wise, the structure after isothermal treatment may not be uniform. In any event, isothermal quenching in the upper portion of the curve will present an ideal method in treating deep hardening steels that may be susceptible to cracking if they were cooled in air after the forging operation.

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OUR DRIVERS

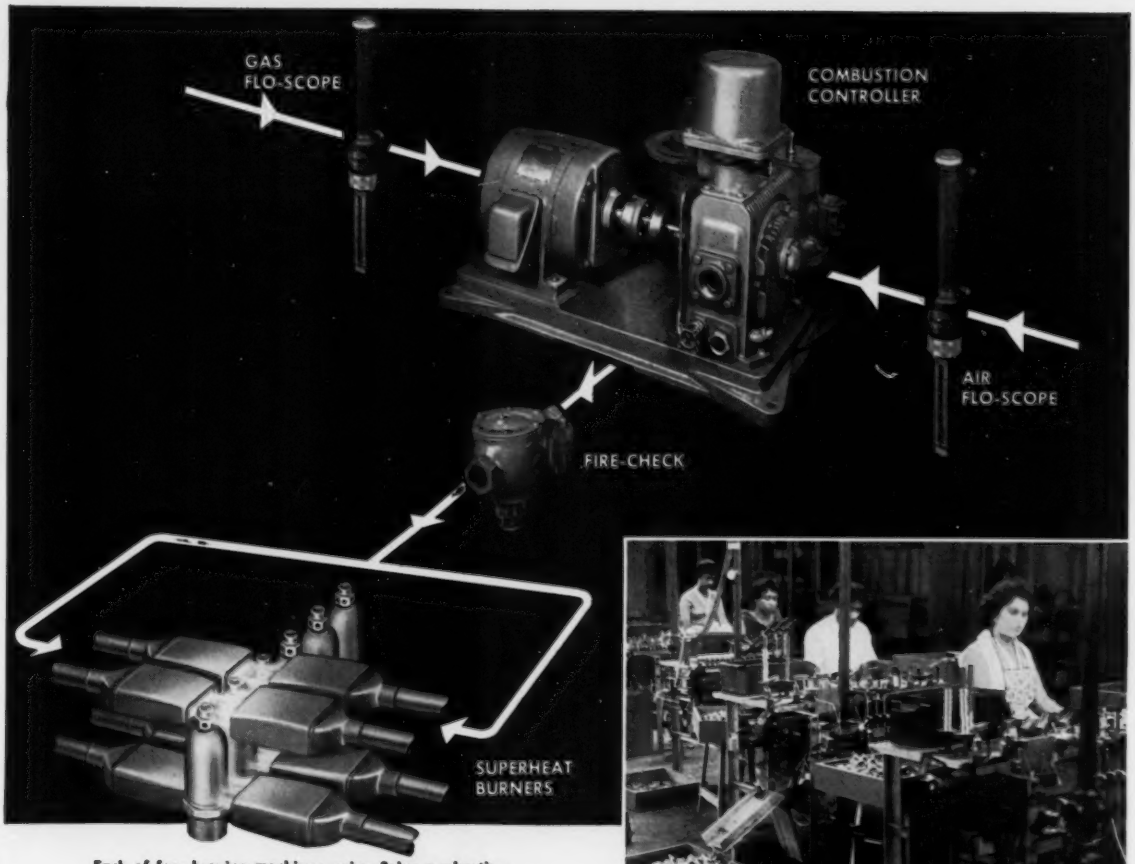
No matter how the weather,
Snow or ice or sleet,
With care our drivers carry on,
On highways or the street.
At every crossing, danger lurks
Awaiting for his prey,
But skillful drivers know full well
There is no right of way.

A man is not a driver
By sitting behind a wheel.
He has many duties to perform
When his truck is standing still.
With tongue in cheek, unloading,
He hears a customer say,
"Where in h---'s that die of mine?
It was promised for today."

He bluffs, through all his shippers
Tho, he hadn't seen the die.
Then like a foreign diplomat,
He explains the reason why.
Sometimes the customers understand,
The driver's not to blame.
But a broken promise hurts a lot
When service is their aim.

In tribute to our Drivers then,
Give them a rousing cheer,
For services rendered in the past
And every day this year.
And let us all cooperate
So they may proudly say,
"Your rush jobs, sir, are on my truck.
I've got them all today."

Jack Fraser



Each of four brazing machines, using Selas combustion components, is capable of brazing 600 air-venting valves per hr at Flair Manufacturing Co., Brooklyn, N.Y.

Individually—or as a package—Selas combustion tools will improve your heat processing!

Selas combustion components are available individually, or as a complete combustion package, to meet your heat processing needs. The Selas combustion system illustrated above consists of:

- *Superheat Burners*—using only commercial fuel gas and air - with no bottled oxygen - provides fast, localized heating effects. Superheat Burners can be utilized in open arrangements . . in-line . . in circular rings . . in spirals . . individually . . in opposed pairs. (Bulletin SB-1)
- *Combustion Controller*—by delivering gas-air mixture to burners at preset ratio and pressure, makes possible fast heating and close control. Completely automatic . . no labor required in its operation. Factory Mutual approved. (Bulletin CC-1)
- *Flo-Scopes®*—installed at the inlets to the Combustion Controller, measure rates of flow of gas and air and permit accurate determination of gas-air mixture ratios. (Bulletin FS)
- *Fire Check*—gives complete assurance of safety by automatically extinguishing any flashbacks that may occur. Factory Mutual approved. (Bull. CS-1)

Selas also offers other types of burners, including Duradiant®, Refrak, Spear-Flame and Ribbon.

For descriptive literature about any of the above combustion components or information about Selas complete combustion packages, address Mr. P. Berg, General Industry Div., Selas Corporation of America, 65 Dreshertown Road, Dresher, Pa.

Duradiant and Flo-Scope are registered trade names of Selas Corporation of America

SELAS CORPORATION OF AMERICA
DRESHER · PENNSYLVANIA

HEAT AND FLUID PROCESSING ENGINEERS development · design · construction

For further information circle No. 40

Invisible Acid Glove

The remarkable protective power of an industrial barrier cream is shown in this dramatic picture. These hands were coated with "Kerodex" type 71 barrier cream, widely used in American industry as a protection against irritants. Then a bottle of pure hydrochloric acid was slowly poured into the palm, running down and around the fingers before splashing off. During part of this test, the hand was clenched and unclenched to prove the resilience of this "invisible glove." After washing, inspection of

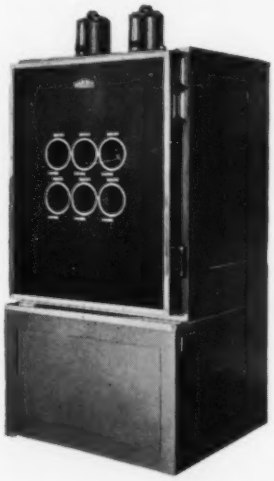
the skin revealed no trace of burning or blistering.

This cream is made in several types to provide workers with positive protection against hazards of skin-damaging chemicals and irritant agents.

For further information circle No. 43

Harris Precision Control

Point control ± .1 C. in repeatability, speed of response, and on-off differential plus temperature variation of less than 1 C. within the 6 cu. ft. chamber are provided



by this new Harris Environmental Chamber, Model 6L-A2-20. A single-chamber cabinet with temperature range of -20 C. to -85 C., the machine affords complete recovery in ten minutes with 1000 BTU product load at -65 C.

Air circulation is positively controlled by two blowers operating in a specially designed plenum chamber. The door is made to accommodate a wide variety of sizes and shapes of fixtures for holding parts during test, or it may be inexpensively modified to meet any requirement. Door and cabinet trim, drip tray, and the interior are all of #304 stainless steel.

For further information circle No. 44

From school room to tool room an investment in Hevi-Duty Furnaces pays triple dividends

Your first dividend comes when you call a Hevi-Duty Sales Engineer. He is far more than a "nuts and bolts" salesman. He is qualified to lay out the most efficient over-all heat processing system for you. His services are yours for the asking.

Your second dividend comes with units that fit your system *exactly*. Better yet, they may well be standard designs for they come from the most complete line of electric and fuel-fired furnaces and ovens available.

Your third dividend is rugged, heavy-industrial quality. No one would say Hevi-Duty furnaces will *never* wear out, but hundreds of old-time users are still wondering *when*.

Why not call a Hevi-Duty Sales Engineer to discuss your heat-processing problems? These users did. Now they are enjoying the dividends.

HEVI-DUTY

Electric and Fuel-Fired Industrial Furnaces and Ovens

B P C

A Division of Basic Products Corporation

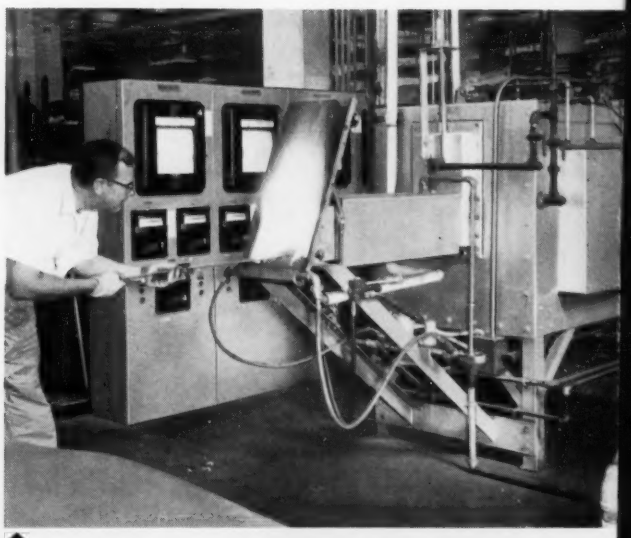
Hevi-Duty Electric Company, Milwaukee 1, Wis.

Adult education classes in a Wisconsin high school use this Hevi-Duty 051-PT muffle furnace for copper enameling. In constant use for 12 years, it still has all four original heating units. Clean, safe, and easy to operate, this furnace provides uniform chamber heat with negligible heat loss despite frequent door openings. ***For complete information on this muffle furnace, write for Bulletin 849.***

For further information circle No. 46

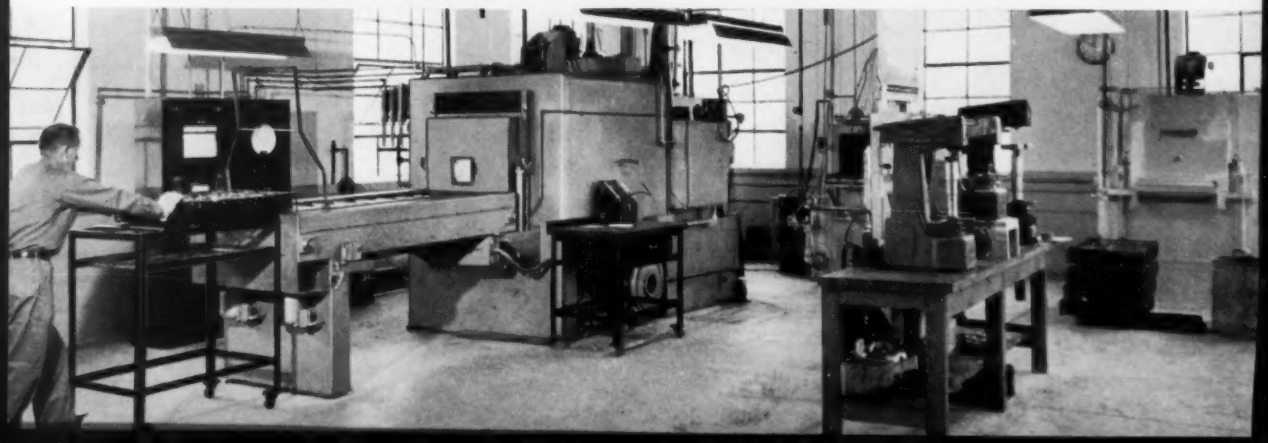
Bedford Gear and Machine Products Co., Bedford, Ohio, eliminated $1,000 per month in scrap losses with this Hevi-Duty Clean-Line automatic heat-treat unit. This heat-treating system includes enclosed quench furnace, washer, atmosphere draw furnace, and endothermic generator. ***For more information, please send for Bulletin D-100.***

For further information circle No. 70



Burroughs Corp., Plymouth, Michigan, reports no scale, no oxidation, and no distortion on high-speed tools and dies hardened in this Hevi-Duty high-temperature furnace. It has two zones of control, a water-jacketed cooling chamber, and maintains uniform temperatures up to 2300°F. ***For more complete information, please send for Bulletin 653.***

For further information circle No. 71



MANUFACTURERS' LITERATURE

For your copy circle the number on the Readers' Service Card

The Uddeholm Company of America has just released an illustrated pamphlet on **UHB Calmax,** their newest Hot Work Tool Steel. UHB Calmax is an air or oil hardening chromium - tungsten - cobalt steel especially recommended for hot pressing dies, mandrels, extrusion dies, die casting dies for copper, brass and similar alloys with high melting temperatures—wherever the highest hardness and wear resistance must be retained through elevated production temperatures. The pamphlet discusses the characteristics and uses of the steel, and gives detailed information on treatment in forging, annealing, stress relieving hardening and tempering. Diagrams graphically show the effects of various temperatures on hardening and tempering, giving Rockwell C hardness statistics.

For further information circle No. 47

Turco Pretreat is the title of a technical data bulletin now available from Turco Products, Inc., Wilmington, California. The booklet gives details for a new process for rapid descaling of a range varying to high temperature alloys. This process is said to be particularly effective when applied to these materials before heat treatment. After treatment it is easily removed, having prevented formation of all oxides, carburization, and scale of any type.

For further information circle No. 48

Bulletin CRS-60 describes the Kentrall line of **Four New Motorized Hardness testers** manufactured by The Torsion Balance Company, Clifton, New Jersey. By removing major test loads automatically, these new motorized hardness testers increase reproducibility of test results and raise the productive capacity of the machine. The cost of these motorized testers is the same as hand-operated machines. The Motorized Kentralls are available in combination testers which provide both regular and superficial Rockwell Hardness testing in a single machine. For those applications that do not require the additional range, these motorized testers are also available as single-purpose instruments for either Regular or Superficial testing alone.

For further information circle No. 49

Lindberg Engineering Company announces the availability of Bulletin No. 260 describing and illustrating the **Lindberg Full Muffle Hydrogen Atmosphere Hand Pusher Furnaces** for bright hardening and annealing of stainless steels and other high alloy materials. The bulletin also contains a furnace cut-away drawing with dimensions and a chart of furnace specifications for both the electric and gas types.

For further information circle No. 50

General Electric Exalene Gas Producers—GED-3995—lists features and advantages of General Electric exalene, exothermic, gas producers for bright annealing, normalizing, brazing and sintering of low-carbon steels, brass and copper. The four page illustrated publication discusses burner installation, controls, cooling unit and mixing equipment. Operating data, ratings and dimensions are also included.

For further information circle No. 51

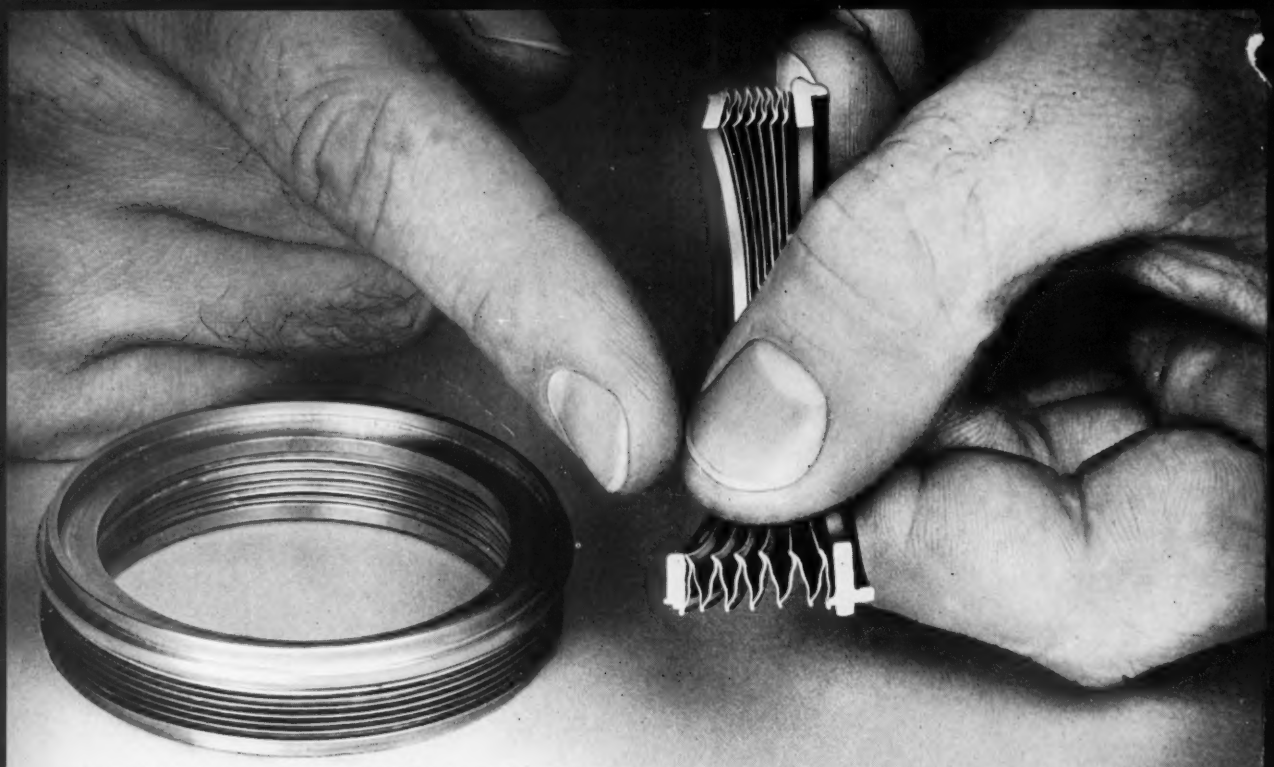
Industrial Furnaces is the general title of a bulletin covering the full line of Sunbeam industrial furnace equipment for heat processing. The brochure includes a special selection guide which enables readers to select the proper equipment in relation to their particular heat process requirements.

For further information circle No. 52

Simple and inherently stable **Temperature Control Packages,** known as Simplytrols and applicable to a wide variety of industrial processes, are described in a new 12-page Bulletin 108, just issued by Assembly Products, Inc., Chesterland, Ohio. The bulletin explains operation, circuitry and safety features of the three basic types of thermocouple-actuated Simplytrols, including the proportioning model that is capable of holding temperature to ±1 F. of set point. Other types are the manual rest and automatic on-off controls. The bulletin includes prices and complete ordering information.

For further information circle No. 53

For further information circle No. 54



PART: Welded bellows-type seal. **MATERIAL:** Type 410 Stainless Steel. **SPECIFICATIONS:** To be hardened under close control because of variations in metal sections. Finished assembly to be clean, bright and free from oxides and scale. Seal in photo has been cut to show cross section of the bellows-type seal.

How would you heat treat a part like this?

The stainless steel bellows-type seal shown is used in a number of applications, from refrigerating systems to missiles, where mechanical seals are needed to resist extreme temperatures from —400F to +1200F. Heat treatment is complicated by the wide variation in section between the thin bellows and the much heavier outer rings.

The Sealol Corporation, Warwick, R. I., solves the problem with a Hayes electric furnace equipped with GLOBAR® silicon carbide heating elements. Depending on the material of the welded bellows (stainless steels of the 300 and 400 groups, precipitation hardened steels such as AM350, 17-7PH, Inconel X, etc.), hardening is between 1700F and 1900F, followed by muffle cooling, both in a hydrogen atmosphere.

GLOBAR elements make possible the precise temperature control and clean heat, independent of the atmosphere, required in this critical operation. Rod-type element simplifies design, furnace construction and servicing. Losses are minimized because all heat is produced and contained inside the furnace.

The many advantages of heating with GLOBAR elements often more than cancel out differentials in BTU costs between electricity and other fuels. Why not investigate with your furnace builder—or write to Refractories Division, Globar Plant, Dept. MP-60, The Carborundum Co., Niagara Falls, N. Y.

For latest advances in silicon carbide heating elements... count on

CARBORUNDUM®

For further information circle No. 55

For precise, economical electric heating

GLOBAR silicon carbide heating elements

- Shipped from stock or within two weeks.
- Temperatures from 1400 to 2800 F, precisely controlled, independent of atmosphere.
- Easily replaced from outside without waiting for furnace to cool.
- "On line" operation for many applications—no transformer necessary.
- Rods 4" to 105" in length.
- For greater economy in heat treating, brazing, forging, melting, and sintering.

MANUFACTURERS' LITERATURE

A new 4-page Data Sheet NY2(1) **Speedomax H Range Conversion,** available from Leeds & Northrup Company, provides a guide to selecting the necessary components—scale, chart, circuit panel, etc.—to change the range of any standard Speedomax H instrument. A master table on the sheet lists the basic items required to change range (1) for the same type of primary element, or (2) from one type of primary element to another (e.g., thermocouple to Rayotube detector). Individual tables list the specific part numbers of scales, charts, etc. for each type of range. Wiring diagrams to simplify electrical connections are also listed.

For further information circle No. 56

An 8-page pamphlet on their UHB Premo Tool Steel, a steel used for producing molds for plastics, and die casting dies for zinc and other metals with low melting points has been announced by Uddeholm Company of America. The pamphlet describes UHB Premo as a low-carbon tool steel, having good case-hardening characteristics, good hobbability especially for deep and intricate cavities, and high wear resistance after heat treatment. Detailed information is given for forging, stress relieving, carburizing, quenching, tempering and martempering. Photographs show various molds and dies for typical applications. Graphs are given to illustrate the effects of carburizing time on carburizing depth, and tempering temperature on surface hardness.

For further information circle No. 57

A new "how-to" book, **Photomicrography of Metals,** a reference guide for metallurgists, has been published by Eastman Kodak Company. The 46-page data book may also serve as a short course in photomicrography for those metallurgists interested in reviewing the latest techniques in this field. In addition, the booklet should prove a valuable addition to metal industry technical libraries as well as serving as a supplemental text for college-level metallurgy students. It is illustrated with photographs, charts and graphs. Written in layman's language, the booklet contains six major sections which include detailed information on the metallographic microscope, illumination, filters in metallography, photographic materials, exposure determination, and processing and printing.

Available through many Kodak dealers, the booklet is priced at 50 cents. The booklet may be also ordered directly from Sales Service Division, Eastman Kodak Company, Rochester 4, New York, for 50 cents plus 10 cents for handling.

General Electric Mesh-Belt Furnaces —GED-3881—is a four-page bulletin which describes features and advantages of General Electric ribbon or silicon carbide resistor mesh-belt furnaces for copper brazing, silver brazing, sintering and bright annealing. The illustrated publication contains tables of furnace dimensions and typical production curves.

For further information circle No. 58

Photomicrography Print Development is the feature article in Volume VI, Issue I, of *Metal Digest,* bi-monthly external house organ of Buehler, Limited. The report, by Cornelius A. Johnson, widely known metallurgist also contains a scale showing the schematic representation of relationship between negative transmission scale, printing paper scale, and tonal quality of prints.

For further information circle No. 59

Metal Processing Bulletin 57-108, 8 pages, 2 colors, gives full information on infrared ovens and components for metal processing applications. Typical installations are shown.

For further information circle No. 60

From left to right: Stanley Pyciak, Purchasing Agent; Richard Hammerstein, Park East Lansing Representative; J. H. McKlveen, Chief Metallurgist; William Pickell, Foreman Heat Treating Department.

"PARK'S NU-SAL and THERMO-QUENCH . . . give us excellent results . . . in austempering automatic transmission bands to exacting specifications."

J. H. McKlveen, Chief Metallurgist, Kelsey-Hayes Wheel Co., Jackson, Mich., says, "Our problem is one of supplying the heavy demands of the automobile industry for automatic transmission bands to their exacting specifications.

"We austenitize these bands at 1550-1600 degrees F. in Park Nu-Sal for seven to ten minutes depending on the thickness of the band. They are then quenched at 650 degrees F. in Park Thermo-Quench for seven minutes. These operations are followed by a cold water quench, hot water rinse, and a soluble oil bath for preservation until use.

"The reason we use Park Chemicals? Over a period of years, we've found Nu-Sal and Thermo-Quench meet our toughest requirements. When you are doing a high volume job, any stoppage is a major problem. Park chemicals have helped us reduce downtime—up production. And one other thing, you can't beat Park for service and delivery."

For complete data on Park Nu-Sal Neutral Salt write for technical bulletin H-2. For complete data on Park Thermo-Quench write for technical bulletin H-19. Park Chemical produces a complete line of heat treating and quenching materials and would be happy to help you work out a solution to your heat treating problems without obligation. Call or write today.

Park

Woodside Rapid Carburizers (Non-Burning—Charcoal—Coke—Specification) ● Park-Kase Liquid Carburizers ● Quenching and Tempering Oils ● Cyanide Mixtures ● Neutral Salt Baths ● High Speed Steel Hardening Salts ● Iso-Thermal Quenching and Tempering Salts ● Protective Coatings (No-Carb—No-Kase—No-Scale—No-Tride) ● Carbon Products (Charcoal—Crushed Coke-Pitch Coke—Lead Pot Carbon) ● Kold Grip Polishing Wheel Cement ● Par-Kem Metal Cleaners ● Cutting and Grinding Compounds (Kem-Cut—Kem-Grind—Blue Ice)

PARK CHEMICAL COMPANY 8074 Military Ave. ● Detroit 4, Mich.

For further information circle No. 62

This model of the "MT" series Pereco Gas-Tight Electric Tube Furnace incorporates a 5" I. D. impervious mullite tube. Silicon-carbide heating elements are positioned perpendicular to, and over and under, the tube. These elements are divided into three separately controlled banks, each with its own transformer and 36 taps (fine to coarse) to provide for wide range, precision power input control of the 30" long hot zone.

Gasketed metallic seals at both ends of the tube insure gas-tight closure. Loading end of tube provides a preheat zone. Unloading end has a water-cooled jacket and provision for connecting a vacuum system for drawing a vacuum in the tube for gas-free atmosphere. Unit's overall length is 60". Case is reinforced, welded steel with super-duty, graded insulation.

Available in other sizes or modifications. Write.

STANDARD AND SPECIAL UNITS
450 to 5000 F.

PERECO
gas-tight
TUBE FURNACE

for precision control of temperatures up to 2800° F

Also Available

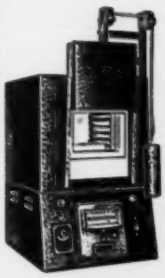
Kanthal-Super Element equipped Pereco Furnaces and Kilns for continuous operation at temperatures up to 2950 F. in oxidizing atmosphere.

PERENY EQUIPMENT COLUMBUS OHIO

PERENY EQUIPMENT CO., Inc.

DEPT. O, 893 CHAMBERS ROAD
COLUMBUS 12, OHIO

For further information circle No. 63



Be sure of Maximum Heat Treating Efficiency with

HUPPERT FURNACES

- Range: 300° F. to 2000° F.
- High temperature, heavy-duty Kanthal elements
- Multi-insulation
- Counter-weighted, tight-sealing door
- Operational pilot light
- Shipped ready to operate

Request literature on complete line of Huppert furnaces and ovens.

Model No.	Inside Dimensions			KW	Prices 220 Volt Single Phase	
	Wide	High	Deep		With Huppert Input Controller	With Electronic Temp. Controller
869	8"	6"	9"	4	$296.00	$480.00
11*	8"	6"	12"	4	306.00	518.00
12*	8"	8"	12"	6	382.00	590.00
12A*	8"	8"	18"	9	490.00	698.00

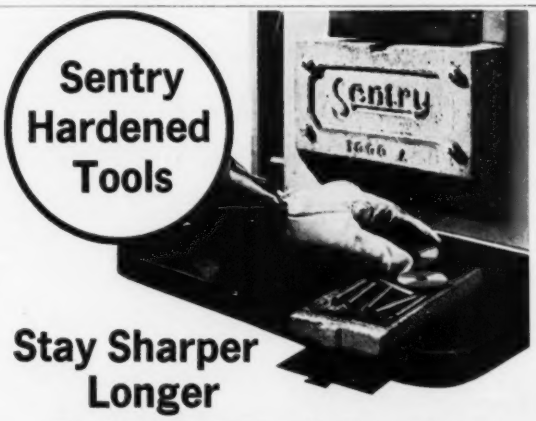
*For 2300° F. add $95.00 to No. 11 and No. 12, and $105.00 to No. 12A. No. 12A can be furnished for 3 phase at no additional cost. For floor model add $52.00 to above prices. No. 869 standardly supplied for 2200°F.

K. H. HUPPERT CO.
Manufacturers of Electric Furnaces and Ovens

684° Cottage Grove Ave., Chicago 37, Illinois

For further information circle No. 65

Sentry Hardened Tools



Stay Sharper Longer

There's no better "insurance" against costly, premature dulling of your high speed production tools than reliable Sentry hardening. Sentry's unique Diamond Block provides a truly neutral atmosphere that permits heat treating for maximum hardness without danger of scale or decarburization . . . keeps your production tools sharper longer.

Like a free demonstration? Send us your sample high speed steel tool and we'll Sentry harden it for you free of charge.

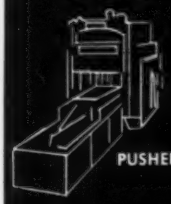
9-0

Sentry TRADEMARK **ELECTRIC FURNACES**

REQUEST CATALOG D-15, WRITE THE SENTRY CO., FOXBORO, MASS.

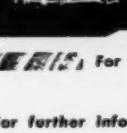
For further information circle No. 64

MEET ALL TYPE FURNACE FIXTURE NEEDS... ECONOMICALLY.


PUSHER


SALT


PIT


BELL

No matter what type of heat treating furnace you have . . . complex or simple . . . a Wiretex-made fixture will handle it easier, better and at less cost.

Fixtures • Retorts • Baskets Pots • Trays • Boxes • Grids Screens • Muffles • Etc.

Any form, size, weight, strength, mesh, alloy or quantity.

Cost Conscious? Call Wiretex. Ask for Catalog M7.

Specialists in Processing Carriers Since 1932.

Wiretex mfg. co.,
16 Mason Street, Bridgeport 5, Conn.

For further information circle No. 66

EQUIPMENT AN

AMMONIA, ANHYDROUS

ARMOUR INDUSTRIAL CHEMICAL COMPANY
DIVISION OF ARMOUR AND COMPANY
110 North Wacker Drive
Chicago 6, Illinois

AMMONIA STORAGE EQUIPMENT

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Cranston 10, Rhode Island

CARBURIZING COMPOUNDS

PARK CHEMICAL COMPANY
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DISSOCIATORS, AMMONIA

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Shelbyville, Indiana

ROLOCK, INC.
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EVAPORATIVE COOLING

NIAGARA BLOWER COMPANY
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GENERAL ALLOYS COMPANY
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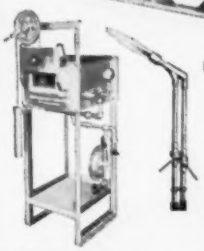

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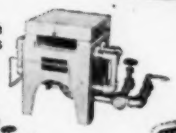

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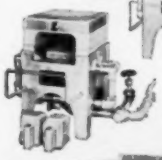

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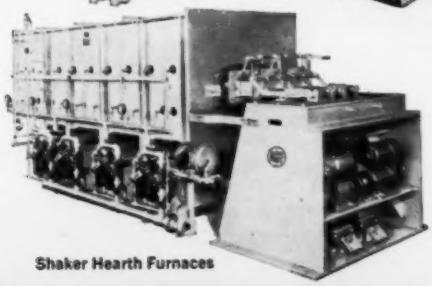

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. . . And furnace maintenance has been lower than their best expectations.

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